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ANNUAL REPORTS

OF THE

DEPARTMENT OF AGRICULTURE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1904.

REPORT OF THE

SECRETARY OF AGRICULTURE.

DEPARTMENTAL REPORTS.

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REPORT

OF THE

SECRETARY OF AGRICULTURE.

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SECRETARY OF AGRICULTURE.

To the President:

I have the honor to submit herewith my Eighth Annual Report as Secretary of Agriculture.

INTRODUCTORY.

Since my last report progress has been made in securing cooperation with the experiment stations of the several States and Territories; some of the Bureaus of the Department make research in conjunction with all the stations. Preliminary steps have been taken to conduct feeding and breeding experiments in several States looking to the development of breeds of animals suitable to our conditions of climate and soils, and capable of meeting the demands of commerce at home and abroad.

Emergencies arising through the invasion of the cotton-growing States by the boll weevil, a Central American insect that has done much damage in Texas and threatens the entire cotton-growing section of our country, have been met by vigorous work that promises to enable the planters to grow crops in defiance of the pest. The spread over several of the mountain States of a cattle mange required vigorous intervention by the Department. It was necessary to detail a large force of experts to supervise the dipping of the herds in order to eradicate the parasite. Cooperation with most of the States has been arranged, and the rest promise to secure State legislation to compel all flock and herd masters to clean their stock.

The demand in the States for experts to supervise the building of roads suggests the education of engineers in the road laboratory for that work.

The efforts of the Department to create a hardy orange tree that would produce a sweet orange have at last been successful. A hybrid of the Florida orange and Japanese trifoliata has fruited and given us

the desired result. Another hybrid gives us an orange very similar to the grape fruit, and a third gives us a fruit equal to the lemon for all practical purposes. Other fruits of these hybrids will be valuable for marmalades and cooking.

Valuable research has been made in fruit shipping to foreign countries; the value of promptly placing fruit in low temperatures as soon as it is taken from the tree is demonstrated.

The value of nitrogen-fixing bacteria has been thoroughly proved, greatly increasing yields of leguminous plants and the accompanying production of nitrogen in the soil.

Progress is being made in introducing plants that succeed in light rainfall localities.

Importers of foods and drinks are obeying the law with regard to adulterations and false labeling.

The elements of agricultural science are gradually finding their place in the primary and secondary schools, through the instruction of teachers.

We buy over $200,000,000 worth of products from tropical countries that can not be grown in continental United States. Through scientists sent from the United States to the several island groups the Department is instructing the people of our island possessions to grow these things, such as coffee, rubber, fibers, drug plants, nuts, fruits, spices, and the like.

Our farmers buy $100,000,000 worth of machinery every year. A better knowledge of its use and care is necessary. Several agricultural colleges are taking up this inquiry, and giving instruction in regard to machinery and farm buildings.

AGRICULTURE AS A SOURCE OF NATIONAL WEALTH.

Favored with continued prosperity in 1904, the farming element of the people has laid broader, deeper, and more substantial the foundations of a magnificent agriculture. These happy results have augmented the similar ones of 1903, so that a period of some industrial depression during the last two years has been saved by the farmers from the severer conditions that must otherwise have befallen in consequence of the absorption of a large portion of the readily convertible capital of the nonagricultural classes into great and prevalent speculations. Thus it has happened the farms of the nation have been that sustaining power upon which a basic dependence must be placed in all stresses by a people endeavoring to maintain economic self-sufficiency.

WEALTH PRODUCED BY FARMERS.

As great as the financial successes of agriculture were in 1903, hitherto without equal, those of 1904 advanced somewhat beyond them. While some products have fallen behind in value others have more

than filled the deficit, and the general result is that the farmers have produced in value much more wealth than they ever did before in one year.

One conspicuous item that has contributed to this is the corn crop. With a quantity closely approaching 2½ billions of bushels, near the record crop of 1902, the high price of this year gives this crop a farm value much greater than it ever had before, far exceeding a billion dollars. With this crop the farmers could pay the National debt and the interest thereon for one year, and still have enough left to pay the expenses of the National Government for a large fraction of a year. The cotton crop, including seed, became the second one in value in 1903, and remains so in 1904. It is now too early to state even with approximate accuracy what the farm value of this crop is, but indications are that the farm value of lint and seed must reach $600,000,000. In this case, as in the case of all other statements herein made concerning crop values for 1904, it must be borne in mind that the amounts have not been finally determined by the Department, that the figures may be considerably changed when the annual estimate is made in the usual way, and that the values are at the farm, and are not commercial values at the exchange or anywhere else.

Hay and wheat are contending for the third place in point of value, although for many years one or the other has held second place or been next to corn. It is expected that these crops, hay and wheat, will together be worth on the farm this year nearly as much as the corn crop, or appreciably more than one billion dollars. Although the wheat crop has a considerably lower production than in any year since 1900, the farm value per bushel is higher than at any time since 1881, so that this is undoubtedly, by a considerable margin, the most valuable crop of wheat ever raised in this country.

It now seems probable that potatoes and barley reached their highest production in 1904; that the oat crop was never so large by 60,000,000 bushels, except in 1902; and that more rice was produced than in any previous year by toward 300,000,000 pounds, so that the present crop of rice has a commercial estimate of 900,000,000 pounds.

The principal crops that are valued annually by the Department or by commercial houses have an aggregate farm value this year which at the date of this writing apparently amounts to $3,583,339,609. The same crops in 1903, as finally estimated, had a farm value of $3,156,099,392 and had a census value for 1899 of $2,526,345,478. In these principal crops, therefore, the farmers find an increase in value for 1904 of 14 per cent over 1903 and of 42 per cent over the census year five years ago.

On account of the difficulty of estimating the present number and value of farm live stock, it must be sufficient to compare the farm equipment in this respect at the beginning of this calendar year as

determined by this Department with similar statements made for 1903. Farm horses have increased slightly in number and more in value, and in the aggregate they never were so valuable as in 1904, with a total of $1,136,940,298. The value of farm mules also reached its highest point in 1904, $217,532,832. Cattle have declined a little in number and more in value, and the same is true with regard to sheep and hogs; but the steady advance of poultry in number and in the quantity and value of products leads to some astonishing values for 1904 when the census ratios of increase from 1890 to 1900 are extended to the present year. The farmers' hens are now producing 1⅔ billions of dozens of eggs yearly, and these hens during their busy season lay enough eggs in two weeks, at the high prices of eggs that have prevailed during the year, to pay the year's interest on the National debt.

UNTHINKABLE AGGREGATES.

After a laborious and careful estimate of the value of the products of the farm during 1904, made within the census scope, it is safe to place this amount at $4,900,000,000, after excluding the value of farm crops fed to live stock in order to avoid duplication of values. A similar estimate made for 1903 gives $4,480,000,000, and the census total for 1899 is $3,742,000,000. It is by no means to be admitted that these figures represent fully the value of the wealth produced on farms. Within the limits of ascertainable values, the farms of 1904 produced an aggregate wealth with a farm valuation that was 9.65 per cent above the product of 1903, and 31.28 per cent above the figures for the census year 1899.

An occupation that has produced such an unthinkable value as one aggregating nearly $5,000,000,000 within a year may be better measured by some comparisons. All of the gold mines of the entire world have not produced since Columbus discovered America a greater value of gold than the farmers of this country have produced in wealth in two years; this year's product is over six times the amount of the capital stock of all national banks; it comes within three-fourths of a billion dollars of equaling the value of the manufactures of 1900, less the cost of materials used; it is twice the sum of our exports and imports for a year; it is two and a half times the gross earnings from the operations of the railways; it is three and a half times the value of all minerals produced in this country, including coal, iron ore, gold, silver, and quarried stone.

FOREIGN TRADE.

In the exportation of their surplus during the year ending June 30, 1904, the farmers of the country kept well up to the high level of recent years. The average annual value of the exports of farm products during the five years 1899–1903 was $864,930,137, and the value

for 1904 was but little below, or $859,170,582. The year 1904 was exceeded by only two years, 1903 and 1901, in the value of exported farm products.

On the other hand, the imports of farm products for the fiscal year 1904 were higher in value than ever before, this value being $462,384,570, leaving an apparent balance of trade in farm products in favor of this country of $396,786,012, or the lowest balance in these products since 1897. The balance declined $25,495,220 in 1904. This is accounted for on the side of imports mostly by increases in the imports of coffee, wool, tea, cocoa, and chocolate; and on the side of exports it is accounted for principally by a decrease of over $72,000,000 in the value of exported grain and grain products which was not balanced by an increase of about $55,000,000 in the value of exported cotton.

During the last fifteen years the apparent balance of trade in favor of this country, all articles considered, was $4,384,574,143. This was owing entirely to the balance of trade in farm products, which during the same time amounted to $5,202,551,016, and was large enough to leave the above-mentioned balance of trade after sustaining adverse balances in products other than those of the farm, amounting to $817,976,963.

INCREASE OF FARM CAPITAL.

The subject of the achievements and financial condition of the farming population may be pursued farther. While the farmers have been increasing their annual product of wealth since 1899 from great proportions to still greater ones, the value of their farm property has gone on increasing. Ratios of increase from the last three censuses indicate that since 1900 the farm land with improvements, including buildings, have increased in value $1\frac{2}{3}$ billions of dollars; the implements and machinery, over $100,000,000; the principal classes of live stock (corrected by the Department's information), $240,000,000. Hence the apparent total of the increase in the value of farms and farm property within four years amounts to about $2,000,000,000, a total that seems to be under the fact, since it does not recognize the marked increase in cotton, corn, wheat, and other lands with high crop values during the last two years. The cotton crop brought to planters not merely an increased price per pound, but it at once made cotton lands more valuable to the extent of several dollars per acre, according to numerous reports received by the Department.

EVIDENCE OF THE BANKS.

The improved financial condition of the farmer is indicated expressively by deposits in banks in several States in which there is so little manufacturing and mining that the conditions are chiefly created by

agriculture. The three agricultural States—Iowa, Kansas, and Mississippi—may be selected for a comparison with the United States as a whole. Individual deposits in the National banks of Iowa increased from June 30, 1896, to October 31, 1904, 137 per cent; Kansas, 212 per cent; Mississippi, 286 per cent; the United States, 92 per cent, or much below the increases of the States named. In the State and private banks deposits during this time increased 128 per cent in Iowa, 227 per cent in Kansas, 306 per cent in Mississippi, and 185 per cent in the United States. In the savings banks of Iowa the increase in deposits was 215 per cent, as compared with 53 per cent for the United States. All kinds of banks being combined, the deposits increased 164 per cent in Iowa, 219 per cent in Kansas, 301 per cent in Mississippi, and 91 per cent in the United States.

A similar comparison favorable to the agricultural States may be made with regard to the number of depositors. In the savings banks of Iowa the number of depositors increased 209 per cent from 1896 to 1904, and in the United States 36 per cent. For National banks, comparison may be made between highly industrial and agricultural States as follows: The number of depositors increased from 1889 to 1903 by 145 per cent in Massachusetts, 117 per cent in New York, 258 per cent in Kansas, and 263 per cent in Mississippi. The increase in Iowa was 184 per cent, the low figure being accounted for by the large development of savings banking.

The Comptroller of the Currency has ascertained the average amount of the daily deposits in National banks, and from his statement it appears that the average daily deposits in October in the National banks of Kansas increased 625 per cent from 1889 to 1903, in Iowa 105 per cent, in Mississippi 89 per cent, in Massachusetts 106 per cent, and in New York 207 per cent.

The farmers' rate of financial progress, as evidenced by the foregoing statements, need fear no comparison with that of any other class of producers. The farmer may not become a millionaire, but he is surer than the millionaire to retain his wealth and to have independence in living.

GENERAL DIFFUSION OF WELL-BEING.

The diffusion of well-being among farmers throughout all parts of the country is one of the most conspicuous features of the recent agricultural development. This attracted attention a year ago and is now even more noticeable; because the great South is more especially enjoying this growth of well-being, owing to the enhanced value of the cotton crop in addition to the general progress in agriculture. The Eastern farmer, who was long on the verge of bankruptcy in competition with the virgin soil and rapid expansion of the northern half of the Mississippi River Valley, has sur-

vived that competition and now enjoys more normal conditions, owing to the creation and maintenance of many large near-by markets by many varied industries. The Pacific Coast has long been prosperous with its world-famed specialties; the mountain States are glad with the fruits and promises of irrigation; in the older prairie States the farmer has seen his land go from $1.25 an acre, or from a homestead gift, to $100 and $150; and the "Great American Desert," as it was called when it was nothing but a buffalo range, is now peopled by a progressive race of farmers, whose banks are filled to overflowing with the proceeds of their products.

WEATHER BUREAU.

OBSERVATORY BUILDINGS.

Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more intimate and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations. The erection of buildings by the Weather Bureau saves the amount previously paid for rent of office quarters.

FORECASTS.

Weather forecasts for thirty-six and forty-eight hours in advance have been made daily throughout the year for each State and Territory, and special warnings of gales on the seacoasts, Gulf, and Great Lakes, and of cold waves, frost, heavy snows, floods, etc., have been issued when the advices would benefit commercial, agricultural, and business interests. The North Atlantic and West Indian storm-warning service was continued, and forecasts for the first three days out of steamers bound for European ports were issued daily at 8 a. m. and 8 p. m. In a number of instances European shipping interests were notified of the character and probable course of severe storms that were passing eastward from the American coast. Daily warnings and advices issued in connection with the injurious weather conditions of the year resulted in saving much property.

RIVER AND FLOOD SERVICE.

The floods of the year did not approach in character and importance the overflows of the spring of the year immediately preceding, when over 100 human lives were lost, besides property valued at

over $40,000,000. There were, nevertheless, severe floods at various times, and in the management of the work occasioned by them the river and flood service continued to demonstrate its usefulness and growing efficiency as a valuable branch of the Weather Bureau. That there has been constant progress in the accuracy of its work is evidenced by the more specific and detailed character of the forecasts and warnings in localities where such exact work had heretofore been considered practically impossible. The service performed during the prevalence of the great winter ice gorges in the Susquehanna, Allegheny, and Ohio rivers, with their attendant floods, was especially noteworthy. These gorges were the greatest in the history of the localities, and that their great dangers were minimized is due in no small degree to the timely advices and warnings of the Weather Bureau.

There were minor floods during nearly every month of the year, but each was amply covered by timely warnings. These floods were not in any sense alarming or dangerous, but they nevertheless attained sufficient importance to endanger a large amount of property.

CLIMATE AND CROP SERVICE.

The National weather and crop monthly and weekly bulletins and the annual summaries and monthly and weekly bulletins issued from the 143 section centers, also snow and ice bulletins, daily bulletins issued in connection with the corn, wheat, cotton, sugar, rice, and fruit services during the growing season, and the special snow bulletins issued during the winter by the sections in the Rocky Mountain and Plateau regions have appeared regularly during the year and have been of great value in affording timely information.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

The extensive distribution of daily forecasts by means of forecast cards has continued, and the railway, telegraph, and train services have supplied in the aggregate over 5,000 railroad stations with bulletins generally posted in the waiting rooms for the benefit of employees and the traveling public. The number of addresses on the rural free-delivery list has been greatly decreased as compared with that of the previous year, owing principally to the discontinuance of the afternoon forecast at some of the centers and the transfer of a large portion of this work to the free telephone service. The rural telephone lines are now the best and most economical means of distributing weather information. The forecasts are quickly disseminated, covering a large territory with little or no expense to the Government. By arrangements made with two of the great trunk telephone lines of Ohio the daily morning forecasts are now available for the use of more than 100,000 subscribers in that State, and the records indicate

that nearly one-half of that number have taken advantage of the opportunity to get the forecasts in their homes within a few minutes after their preparation at the district center.

MOUNT WEATHER METEOROLOGICAL RESEARCH OBSERVATORY.

During the past year the main building of the Mount Weather Observatory has been completed, while the power plant, the building from which balloon ascensions and kite flights are to be made, and the magnetic building are being constructed. The physical laboratory for electrical and radioactive effects is being planned, the erection of which will take place in another year. Finally, a comprehensive physical observatory for photographing the sun directly and through the spectrum, for measuring radiation energy by actinometry and bolometry, with their allied equipment, will be required. This complex institution must grow up slowly as plans can be matured along the best modern lines. When the equipment is ready we shall make and send out apparatus for the exploring of the atmosphere to altitudes of from 3 to 10 miles. It is probable that many balloons will be simultaneously liberated from different stations so as to get records of storms and cold waves from their four quadrants. With observations from the magnetic, the electric, and the solar physics observatories, opportunity for study will be given to those who believe that the cyclonic and anticyclonic whirls that constitute storms and cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the purpose to make the research at Mount Weather catholic in its broadness.

WIRELESS TELEGRAPHY.

The Department of Agriculture, through the Weather Bureau, was one of the first of the Executive Departments to take up, systematically, experimentation in problems concerned with the development of wireless telegraphy. By this action research into the physical problems concerned in transmitting messages through the medium of ether waves was greatly stimulated in this country. Probably one of the best, if not the best, instruments anywhere made for the receiving of wireless messages had its inception in the experimental work of the Weather Bureau. Recently a board was appointed by you to consider the whole problem of wireless telegraphy and the relation of the Government thereto. Its recommendations, which you approved, will result in the discontinuance of experiments along this line by the Weather Bureau, their transfer to the Navy Department, and the transfer to the Weather Bureau of all the meteorological work now being done by the Navy Department.

LONG-RANGE FORECASTS.

It is hoped the time will come when it will be possible to forecast the weather for coming seasons, to specify in what respect the coming month or season will conform to or depart from the weather that is common to the month or season; but that time has not yet arrived, and the officials of the Weather Bureau have been informed that they will best serve the public interests when they teach the communities they serve the true limitations of weather forecasting.

EDUCATION IN METEOROLOGY.

The Department is interested in the general introduction of meteorology into the courses of study provided by the universities and higher technical institutions of the country. The mode of teaching and the results obtained were made an important part of the work of the Convention of Weather Bureau Officials which was held at Peoria, Ill., in September, 1904. At an increasing number of educational institutions Weather Bureau officials, in addition to their regular duties and mainly outside of office hours, deliver courses of lectures on meteorology.

TELEGRAPH SERVICE.

To meet as far as possible the pressing demands for a wider distribution of the daily telegraphic reports of observations, arrangements were perfected during the year for a very generous increase in the number of such reports telegraphed over circuits and as special messages, and while for economical reasons it is impossible to satisfy all demands in this respect, it is believed that the present distribution of reports will result in a much more comprehensive display of weather conditions on the maps and bulletins and will give general satisfaction both to the public and to our officials charged with making district and local forecasts. Submarine cables have been laid from Block Island, Rhode Island, to the mainland; from South Manitou to North Manitou Island, Michigan; from Flavel, Oreg., across the mouth of the Columbia River to Fort Canby, Wash.; and preparations are being made for laying one from North Nags Head to Manteo, Roanoke Island, North Carolina.

The reorganization at the beginning of the year of the vessel and wreck reporting service of the Weather Bureau, with additional stations at Sand Key, Florida, and Southeast Farallone, California, has largely added to the effectiveness of this popular feature of the Bureau, and is much appreciated by maritime interests generally. Vessel and wreck reports are now furnished free of charge, except for telegraph tolls over commercial lines, to all corporations and individuals who

may apply for them. Besides reporting passing vessels, an important service is rendered by these stations in connection with maritime disasters.

INSTRUMENTAL EQUIPMENT.

The Bureau has now 158 stations completely equipped with instruments by means of which an automatic record is made of the direction and velocity of the wind, the duration of sunshine, the amount and time of beginning and ending of rainfall, and the temperature and pressure of the air. With one or two exceptions the stations that are not at present so equipped are of slight importance, or in general have all the instruments necessary for the satisfactory performance of their work. One hundred and fifty-nine steel towers, with the improved auxiliary equipment for the display of storm warnings, are now installed at as many stations distributed over the shores of the Great Lakes and the Atlantic and Pacific seacoasts. At 77 of these stations high-power electric lanterns are used, and at the others improved oil lights.

BUREAU OF ANIMAL INDUSTRY.

Our animal industry is shown only in small part by the figures giving the exports, yet these exports are so large as to be worthy of notice. The animals exported in the fiscal year 1904 were valued at about $48,000,000, which was an increase over the previous year of $13,000,000; the exports of meat and meat products, including oleo oil, oleomargarin, and lard compounds, amounted to more than $174,000,000, a decrease of $4,000,000 from the year before. We also sent abroad nearly $6,000,000 worth of dairy products, and of other animal products, such as hides and skins, glue, grease, and grease scrap, over $5,000,000 worth. The exact total of the above items of export, as given in preliminary returns, was $223,023,060, which was an increase over the previous year of more than $12,000,000. The Department is fostering this foreign trade, as well as safeguarding the live-stock industry within our own country.

INSPECTION OF ANIMALS FOR EXPORT.

The inspections of live stock for export included Canadian animals that pass through territory of the United States; these numbered about 26,000 cattle and 60,000 sheep. The total inspections for export, including these Canadian animals, were 790,496 for cattle, 534,850 for sheep, and 3,293 for horses. As compared with similar figures for the fiscal year 1903, this statement shows an increase of 43.7 per cent in the number of American cattle exported and an increase of 116.5 per cent in the number of American sheep exported. The number of horses exported, however, was reduced by one-third.

The percentage of loss in transit for the 360,990 head of American cattle landed at the ports of London, Liverpool, and Glasgow was but 0.17; the percentage of loss for the 212,299 American sheep landed at the same ports was 0.94.

The number of clearances of vessels engaged in carrying live stock was 774, and the certificates of inspection issued for American cattle exported to Europe numbered 1,419.

INSPECTION OF IMPORT ANIMALS.

The work of the inspection of import animals calls for the utmost vigilance in order to prevent the introduction of diseases which might prove disastrous to the live stock of this country. Most of the animals that came through the seacoast ports of entry were imported for breeding purposes, but a considerable number of cattle were admitted from Mexico for feeding. The importations of pure-bred animals subject to quarantine were very light during the year, the number at New York, the chief port of entry, having been 266 cattle, 128 sheep, and 123 hogs. The number of farm animals that came through seacoast ports and not subject to quarantine was 2,492; of this total 2,425 were horses. We brought from Great Britain 1,523 horses, from Germany 204, from Belgium 651, and 47 from other countries.

The importations of animals from Mexico were 12,088 cattle, 701 sheep, 314 horses, and various other animals to the number of 203.

An unusually large number of ruminants for menageries, all of which were subject to inspection and quarantine, were imported during the year.

INSPECTION OF MEAT.

The inspection of animals and animal products was maintained at 51 establishments and cities. The total number of ante-mortem inspections was about 65,000,000, whereas in 1903 the number was about 59,000,000; this shows an increase of 6,000,000 animals. The post-mortem inspections amounted to nearly 40,000,000, which was an increase, except as to sheep, over the year 1903. The increase in 1904 in the number of hogs inspected post-mortem was over 2,000,000.

The meat-inspection tag or label was affixed to 22,943,067 quarters and 120,404 pieces of beef, 8,230,528 carcasses of sheep, 765,301 carcasses of calves, 1,122,193 carcasses of hogs, and 726,779 sacks of pork. Besides, the meat-inspection stamp was affixed to 23,000,000 packages of meat and meat products that had received the regular post-mortem inspection.

Compared with the figures of 1903, the statement for 1904 shows an increase in beef exports of 47,138,044 pounds, a decrease in mutton exports of 2,016,924 pounds, and an increase of pork exports of 21,319,830 pounds—a net increase of 66,440,950 pounds for all.

In the matter of the microscopic inspection of pork there was a great decrease, from 19,000,000 pounds in 1893 to 9,000,000 in 1904. This inspection is restricted to the pork that is destined for those countries which require such safeguard. The number of carcasses thus inspected in 1904 was 315,045. The number of carcasses found to be trichinous was 2,643.

The cost of the ordinary inspection was $781,590.95, and the microscopic inspection cost $53,934.01. Each hog carcass cost 17.1 cents for its inspection and each pound of pork exported 0.6 cent.

CATTLE SCAB, OR MANGE.

The existence of scab, or mange, in cattle has for several years past often been brought to the attention of the Department. As early as the spring of 1901 inspectors in the field recognized that scab of cattle was a contagious disease, and asked for instructions regarding it. The disease continued to spread, and during that year numerous inquiries were received as to how the disease could be cured and controlled. It became generally known that the dipping of cattle was the best method of treatment, and the Department received many calls for information as to the construction of vats and the best dips to use. In January, 1902, a bulletin describing scab of cattle and its treatment was issued. There was a large individual demand for this publication and it was supplied to many State authorities for general distribution.

In spite of efforts to disseminate all the information possible on the subject, the disease spread to an alarming extent, especially on the Western ranges, where the cattle roamed over large areas, and where a few infected animals introduced would communicate the disease to others until the whole band was affected. So extensive was the distribution of the scab that in June, 1903, the Department issued regulations for controlling it, stating that the disease existed among cattle in that part of the United States lying west of the Mississippi River, including the State of Minnesota. These regulations did not apply to the Eastern part of the United States. At that time all of the available funds were used for the employment of inspectors in the Western country in the eradication of scabies among sheep, and there were but a few men who could be used for enforcing the regulations for preventing the spread of scabies among cattle. Many of the Western States, notably Colorado, began during this year to take measures for suppressing the malady within their limits. These States, however, were unable to prevent the disease from being introduced from other States, consequently very urgent appeals were made from State authorities asking that supervision by this Department be extended to cattle scab.

It was apparent that, unless the Federal authorities undertook measures for its control, the States would suffer disaster, not only from the loss of stock affected, but from the embargo which would be placed upon cattle passing from an infected State to one where the disease did not exist. The disease became so prevalent that it was carried from the ranges to the feed lots in States of the Middle West, and there was danger of injury to the trade in live cattle for export to Great Britain. When the scab became so common on the ranges, it was found that unless the cattle were dipped before shipment the cars in which they were loaded became infected; also the stock pens, where the cattle were unloaded for food and rest en route, as well as the stock yards at the leading markets. It became imperative, therefore, that a campaign should be entered upon, and accordingly in March, 1904, regulations were issued applying to all of the United States and prohibiting shipment of cattle affected with this disease from one State to another.

Provision was made in these regulations for allowing shipment after cattle were dipped, and, though affected with the disease, they could be shipped for immediate slaughter after one dipping; but if cattle were intended for feeding or stocking purposes, they must be held for the second dipping, ten or twelve days after the first one. To secure the enforcement of these regulations, it was necessary to station a large number of inspectors in the Western States, particularly the range States where shipments of cattle originated and where the disease was most prevalent. So far as possible the force of inspectors already in this region was used; but this was entirely inadequate to the demands and required an extensive increase, so that at the present time more than two hundred men are in the field engaged in the inspection of sheep and cattle for scabies.

There was an urgent call for inspectors, mostly from persons who had cattle to ship and those who owned affected cattle which required dipping. This dipping in several States was done in cooperation with the State authorities and under the supervision of Federal employees. Shipments of cattle from ranges known to be infected could not be made to market centers without a certificate showing freedom from scabies, or to the effect that the cattle had been dipped and could be transported without spreading the contagion.

During the first nine months of this year, in the 34 States and Territories where this inspection was maintained, 3,843,075 cattle were inspected for scab; 168,203 were found affected with the disease, and 300,275 were found to have been exposed to it. The total number of cattle dipped during this period, under official supervision, was 420,762; 116,362 affected cattle were given one dipping, and 76,974 affected cattle were dipped a second time, after an interval of ten or twelve days. This work necessarily increases the expenses of the

Bureau, which, for the month of January, 1904, amounted to $404.65 for this inspection exclusively, and in September, 1904, to $11,770.70.

FOOT ROT AND GID OF SHEEP, AND RABIES.

Besides the several lines of work which have been carried on through a series of years and which have been reported upon from time to time, special work has been done with reference to foot rot of sheep and the disease of sheep commonly known as "gid." In a recent shipment of sheep which arrived at the Buffalo stock yards 75 per cent were found to be affected with foot rot. This disease is not at all uncommon in the sheep-raising parts of the country, and its eradication is not a very difficult undertaking. A bulletin is now in press which deals with all of the phases of foot rot, and should enable the sheep raiser to clean up his flock without much difficulty or great expense.

Although the conditions prevailing in this country are considered unfavorable to the parasite causing gid, the disease, nevertheless, has gained a foothold in the Rocky Mountain States, and it is therefore well to understand the life history of the parasite causing the disease and the methods of dealing with it. It is reported that a few years ago the loss of sheep from gid in France was as great as 1,000,000 annually. This subject has received a thorough investigation, the results of which will soon be published.

Investigations regarding the presence of rabies, or hydrophobia, in the vicinity of Washington, D. C., were continued during the year. Of the 38 suspected cases examined positive results were obtained from 22, of which number 13 were from the District of Columbia.

TUBERCULOSIS.

The work on the subject of tuberculosis has been conducted throughout the year along lines which have been planned for several years. Some experiments which have been recently reported upon by this Bureau go to show conclusively, it is believed, that it is an error to conclude that cattle can not be infected with human tuberculosis. These experiments not only justify but show the desirability of a rigid enforcement of public regulations looking to the control and the eradication of tuberculosis in cattle.

The demand for tuberculin greatly increased during the year. The amount distributed in 1904 was 74,000 doses, while in 1903 the number of doses was 47,000.

DISTRIBUTION OF BLACKLEG VACCINE AND MALLEIN.

The blackleg vaccine for cattle which is manufactured and distributed by the Bureau of Animal Industry continues to give satisfactory results. During the year the number of doses that were sent out fell off somewhat from the report of the previous year, but the number of

persons supplied was slightly increased. It is interesting to note that, in 1904, 1,000,000 doses of the vaccine were used and reported upon by over 10,000 persons with highly satisfactory results. After a careful analysis of the figures which were compiled from the reports from the users of blackleg vaccine, and eliminating the deaths which could in no manner be properly charged against the action of the vaccine, the number of cases that died after vaccination is reduced to the very low figure of 0.44 per cent.

The manufacture and distribution of mallein in 1904 for glanders in horses was about the same as in the previous year, and the number of doses sent out was 7,000.

INSPECTION OF DAIRY PRODUCTS.

Under the act of Congress approved May 9, 1902, the Bureau of Animal Industry is charged with the inspection of certain dairy products which are designed for interstate commerce, especially the article of renovated butter. This work is now fully organized and is governed by joint agreement of the Treasury Department and the Department of Agriculture. The reports for 1904 show that there were 73 factories licensed and bonded, which was a reduction of 9 from the previous year. These factories were located in 14 States and the District of Columbia. The quantity of renovated butter made at bonded factories during the fiscal year of 1904 was about 54,000,000 pounds. The average quality of renovated butter is improving. The difference in general character, since the inspection was inaugurated, is very marked. This is due, in part, to improved machinery and processes, and largely to the better average quality and condition of the "packing stock" or raw material used.

Such stock is now closely collected in the producing districts, so that accumulations of country butter at remote points and involving deterioration are not frequent. More care is taken in sorting, packing, and storing the stock. Occasionally a lot of packing stock is found in such a condition of filth or putrefaction as to necessitate condemnation. In still rarer cases the manufactured product is found to be so bad, because of bad materials, ignorance, or negligence in renovating, or as the effect of age, as to make it unfit for food. In a few such instances the sanitary inspection required by law and made by this Department has caused the objectionable materials and products to be removed from the food market and sold as grease. But, as stated, such instances are not frequent. Although there is still opportunity for great improvement in materials, in the manner of handling and transporting the same, in factory management, and in the finished product, it is true that the manufacturers are endeavoring, as a rule, to improve conditions at all points and are ambitious to win a reputation for producing an article of high quality.

BUREAU OF PLANT INDUSTRY.

In no field of industrial work have there been greater advances during the past decade than in the improvement of plants and the methods of growing them. The Bureau of Plant Industry has done much to bring about these advances. Diseases have been studied and remedies found, new varieties of plants have been created and new industries established, and the world has been searched for better things, all for the purpose of helping the farmer and making his work less burdensome and more profitable.

GROWTH OF THE WORK.

Since the Bureau of Plant Industry was organized, three years ago, the demand for more work has been so great as to require an increase of nearly 50 per cent in men and funds to conduct it. There are now in the Bureau about 500 workers, 60 per cent of whom are engaged in scientific investigation and its application to the farm, the orchard, and the garden. The Bureau is endeavoring to train young men as rapidly as possible for this work. The agricultural colleges furnish a part of these men, but the demand for those with proper qualifications is still greater than the supply.

ENCOURAGING INTEREST IN FARM LIFE.

The Department is not an educational institution in the strict sense of the word, but it can do and is doing much to bring home to the people in all walks of life the importance and value of the farm and its productions. The Bureau of Plant Industry is making a special effort to encourage the study of plants in the public schools. The future welfare of this country depends upon its agricultural development, and it is important and vital that a knowledge of the opportunities in this field should early be brought to the attention of the child. Unfortunately, our system of elementary education is such as to leave no impression on the child's mind of the importance, value, and usefulness of farm life. The child is, in many ways, brought early into contact with facts which point to him the value of commercial life. He is, therefore, early inoculated with the belief that to reach the highest possibilities he must, if he is on the farm, migrate to the city. It is to be regretted that farm life in the past has not always been conducive to the encouragement of young men to remain on the farm.

Very little effort has been made to overcome the general belief that there is always a great amount of drudgery connected with the farm, and that the opportunities in this sort of occupation are narrow and limited. When we see the rapid advances that are being made in agriculture along all lines and note the need for bright young men in this

field, the opportunities offered by the cultivation of the soil seem as great as in any other field. In order to bring these matters clearly home to the children, efforts are being made by the Department to encourage the growing of plants in connection with the public school work. The general distribution of seed is being handled in such a way that the encouragement of plant growing will be a feature of it. Wherever it has been practicable to influence school authorities, this has been done. Various members of the staff of the Bureau are constantly endeavoring by publication of papers, lecturing, etc., to point out the advantages of rural life.

DEVELOPING NEW INDUSTRIES.

RICE PRODUCTION.

The Bureau of Plant Industry has continued its efforts to encourage rice production in the Southern States, especially in Louisiana and Texas. A special farm for the growing of rice has been placed at the disposal of the Department, and upon this farm various questions relating to the industry are being worked out. New varieties of rice are being tested, questions pertaining to the best methods of improving the seed are being settled, and other important problems are under investigation. There has been an enormous increase in the production of rice in the States of Louisiana and Texas during the past three years. As the industry has developed, the necessity has become more and more evident for paying special attention to the improvement of cultural methods.

In the early days of the industry the crop was so profitable that little attempt was made to obtain information on important matters, such as the necessity for rotation, the best methods of handling the water, means of controlling diseases and weed pests, and other important subjects. As competition has become greater and the production larger, farmers are realizing the necessity for paying strict attention to all details connected with the work. Preliminary estimates show that during the year 1904 the area devoted to rice in Louisiana and Texas was 600,000 acres, and the crop will approximate 650,000,000 pounds of rough rice.

DURUM WHEATS.

The success attending the introduction and growing of the durum or macaroni wheats continues unabated. The past season has been a particularly trying one for all wheats in the Northwest. Rust has caused great damage in many localities, but the durum wheats have been in most cases resistant. Probably no less than 14 million bushels of these wheats will be grown the present season, and the evidence at hand indicates that great quantities of the wheats are being saved for

seed for next year's planting. Owing to the almost total loss of other wheats east of the area where the durum wheats succeed best, efforts will probably be made next year to plant the durum wheats farther east than they should be planted. It must be remembered that these wheats are specially adapted to semiarid regions, and moving them into humid regions may result in disappointment.

It is gratifying to announce that the durum wheats are now being handled without difficulty by many of the millers, and regular grades corresponding with the grades of other wheats have been established in the markets. From the outlook at present there will be not less than 40 or 50 million bushels of these wheats produced next year. The fact that these wheats are valuable for bread and that they can be grown successfully where most other crops fail is an exceedingly important thing for the agricultural development of the great semiarid West.

THE MATTING INDUSTRY.

The United States imports large quantities of mattings from the Orient. These mattings, for the most part, are made of a species of rush which might easily be grown in this country; in fact, there are already here several native forms which undoubtedly would prove valuable for the manufacture of fine mattings. Special American machinery has been devised and is now in use in the manufacture of a very high grade of mattings. So far, the raw material used by these machines has been imported. During the year the Bureau of Plant Industry has introduced and disseminated considerable quantities of the rush, with the object of securing a sufficient amount to supply American manufacturers with the product. The results accomplished have already proved encouraging, and the work will be continued.

SUGAR-BEET GROWING.

The development of the sugar-beet industry continues satisfactory. The Bureau of Plant Industry is making an effort to improve the conditions affecting this crop in the matter of providing better seed, encouraging the use of fertilizers where fertilizers are likely to do good, studying the diseases with a view to discovering remedies for them, securing improvement in the matter of seed by the production of beets which will give seed of a single ball or germ, etc. A little more than two years ago the Department again took up the work of establishing sugar-beet seed culture in the United States, and since that time work has been going on in four representative sections of this country. Strains of pedigreed seed are being established in New York, Michigan, Utah, and Washington State, while in Utah and Washington the industry is already assuming commercial importance.

In California also seed is being produced for local use. In Wash-

ington State 80,000 pounds of seed were produced in 1904, in Utah about 32,000 pounds, and in California about 50,000 pounds—a total of 162,000 pounds. As rapidly as the Department can bring home to all the sugar-beet factories the conviction that American-grown seed is as good and often better than the imported, these quantities will be increased, and it is a question of but a few years when the entire 5,000,000 pounds used in the United States will be produced at home.

As to the quality, American-grown seed has produced beets testing as high as 24 per cent of sugar, while the average percentage in all beets tested from American-grown seed during 1903 was 15.8 per cent. The average percentage of sugar in all beets grown in the United States, as shown by the factory returns of their total extractions, is a little over 11 per cent. It will be remembered, too, that the American seed has the benefit of only two years of careful selection. The work of establishing a pedigreed strain is slow, and years are required for the completion of such an undertaking; but the work is so far along that its success may be considered assured.

Two years ago the Department imported all the sugar-beet seed that was distributed for experimental purposes, while during the 1904 season 14,000 pounds of American-grown seed were distributed by the Department to selected farmers for testing in comparison with imported seed furnished to them by the factories. The reports on the stand secured, which is generally indicative of the yield, show that the American seed gave almost without exception a greater and a stronger growth than the imported seed. In a number of instances those portions of fields which were sown with factory seed gave such a poor stand that they had either to be resown or abandoned, while the portions sown with American-grown seed gave good stands and in no case required replanting. The factories during 1904 bought 34,500 pounds of American-grown seed, and a number of these factories are now negotiating with the American growers for contracts to supply the seed they need.

In the fertilizer work efforts have been made to determine the effect of different fertilizers on tonnage and sugar content, and also their influence on various diseases.

Investigations along this line were undertaken in six sugar-beet States, seven brands of complete fertilizers being used, and in addition some separate experiments with the various ingredients used by themselves were made. The preliminary reports which have been received indicate that in many cases the effect of the fertilizers could be seen from the time of the germination of the beets. In a few cases the lines separating the fertilized from the unfertilized plots could be seen even at the beginning of the harvest. A recent report from one of the experimenters states that in his work with nitrate of soda the beets from the untreated plots were worth $5.20 per ton and yielded

$54.35 worth of beets per acre. On the adjacent plot, where 300 pounds of nitrate of soda were applied at the time of planting, the beets were worth $5.30 per ton and yielded $74.57, a difference of $20.23 per acre in favor of the fertilization. The untreated beets tested 14.1 per cent sugar, while those fertilized tested 14.4 per cent.

The serious epidemics which have affected the sugar beet, like the leaf-spot disease of the East and the curly top of the West, have been investigated. Experiments on a large scale in different sections of the Eastern beet area have shown that the leaf-spot may be readily controlled by the application of Bordeaux mixture. This remedy has now come into general use.

In my last report attention was called to the efforts being made in the matter of developing sugar-beet seeds with single germs. The single-germ seed would do much to diminish the labor of thinning. The Bureau work in this field has been very satisfactory. Although the work has been running for only two seasons, decided progress has been made, and the single-germ seeds that have been selected have been found much more vigorous than the multiple-germ balls. The selected strains grown this year show a decided tendency to the production of a larger number of single-germ balls than the parent beet from which the selection was started, the average gain being about 20 per cent. In one case, over 3,000 single-seed balls were found on one beet. The work this year has been conducted in Utah and other sections where the sugar beet is at its best, and indicates that ultimately we shall in all probability be successful in the production of a beet having the desirable quality of producing only balls with single germs, that will substantially save hand thinning and avoid much expense in growing.

NEW CITROUS FRUITS.

The efforts that have been made by the Bureau of Plant Industry for a number of years in the matter of producing, by breeding, new citrous fruits, so as to build up varied industries in the South, have met with very gratifying results. The hardy sour oranges which have been secured as a result of crossing the sweet orange with the hardy Japanese orange are now ready to distribute, and the work of distribution will be inaugurated in the coming winter. These new hardy oranges will unquestionably make possible the development of several important industries in the South. The oranges are valuable for marmalades, and from the fact that they may be grown in nearly all the Southern States, great possibilities for their usefulness are opened up. Even if they should not come into general use for manufacturing purposes or for general orchard planting, they will undoubtedly eventually become a feature in every dooryard throughout the South. Aside from their value for the manufacture of marmalades and preserves, they will be exceedingly useful for pies and other purposes.

There has been fruited this year for the first time a sweet orange of the hardy type. This is an accomplishment which the Department hoped for when it first inaugurated the work. The other new citrous fruits developed from the Bureau's investigations, such as the new tangelo, which is a cross between the tangerine and the pomelo, a new velvet-skin orange, and several other creations, will all prove exceedingly valuable in sections where the climatic conditions will permit the growing of these more tender sorts.

AMERICAN TEA.

The Department has continued its work in the production of American tea. The more advanced investigations have been conducted, as heretofore, at Summerville, S. C., in cooperation with Dr. Charles U. Shepard. Doctor Shepard's tea gardens are now yielding from 8,000 to 10,000 pounds of tea annually. Owing to climatic conditions the crop this year will be light. Doctor Shepard has been devoting special attention to the improvement of factory processes. Several new inventions have been made by him in the matter of tea rollers, apparatus for the manufacture of green tea, and apparatus for a process of attrition, giving to the tea the beautiful bluish cast, or finish, which heretofore has been secured in foreign countries by the application of various chemicals.

Doctor Shepard's process puts this finish on the teas by simple attrition or friction, and is a marked advance over the old processes. The work of establishing a plantation in Texas has been continued. Tea beds were started on two types of soil—a rich sandy loam and a black, waxy soil. The plants on the black, waxy land have failed utterly. Fortunately this discovery was made before any extensive plantings had been undertaken, and it will lead to the extension of the plantings on the sandy loam soil. There are now on hand at our Texas station, which is located at Pierce, about 100,000 plants, which will be put into the field this winter, planting about 40 acres. Sufficient additional seed will be put out to give another 50 acres next year.

AMERICAN DATES.

Encouraging results have been secured in the establishment of this industry in the southwestern portion of the United States. The date orchard at Tempe, Ariz., is progressing in a highly satisfactory way. The work here has been carried on in cooperation with the Arizona experiment station and has been under the direct supervision of Prof. R. H. Forbes. In cooperation with the California experiment station, work on the establishment of date culture in southern California is also being conducted. Ten acres of land have been secured for an experimental orchard and dates have been and are being planted there.

The industry has been further encouraged by the publication of important reports on the subject, pointing out available localities where the crop is likely to succeed. There is a considerable extent of territory in southern California where practically all of the dates of a certain class which are now imported could in all probability be grown. These regions have been mapped and a special effort has been made to encourage the production of the crop therein. Various importations of the date have been made during the year and others will follow from time to time as the industry advances.

BULB GROWING.

The very specialized conditions of soil and climate necessary for the proper production of bulbs and the peculiar nature of the skilled labor required have made the establishment of the bulb industry difficult. However, investigations have shown that nearly all of the so-called Dutch bulbs may be grown in the United States, and that one by one the difficulties due to competition of cheap skilled labor, excessive cost of transportation, and the natural hesitancy on the part of purchasers to use an untried article will be overcome. A method has also been discovered by the Department experts to produce the Bermuda lily bulb free from disease. Of the millions of lily bulbs annually imported, it is safe to say that 40 per cent are more or less affected by disease. The eventual elimination of this trouble will be due to the work of the Department.

AMERICAN-GROWN DRUG PLANTS.

In Vermont, the previous success in growing opium poppies has been repeated with even more satisfactory results, both the white-seeded and blue-seeded sorts giving good crops. The attempt to cultivate this plant has been made with the object in view of testing the possibility of developing in this country a means of supplying our demand for poppy alkaloids for medicinal uses. The present source of these—morphine, codeine, etc.—is to be found in crude opium, of which approximately a million dollars' worth is imported annually. The cost of these products is in large part due to the labor involved, and the efforts of the Bureau have been directed toward devising some process whereby the alkaloidal principles can be isolated directly from the extracted juices of the plant. Up to the present time no one has succeeded in obtaining morphine from these extracts.

During the year an expert of the Bureau has, however, met with success, and we are now able to obtain morphine directly from the expressed juices of the plant. This method does away with much of the expense. Experiments are now being undertaken to ascertain the practicability of obtaining morphine directly from the plants as a

commercial source. If the experiment indicates a favorable outcome the plants produced in American fields will replace oriental opium as a crude source for morphine.

SWEDISH SELECT OAT.

The experiments of the Department with this hardy Swedish oat ceased some time ago, but highly interesting reports in regard to its usefulness are still coming in. It was introduced about five years ago by the Bureau of Plant Industry and distributed in a number of the Northwestern States. It has high qualities as a yielder and is especially valuable for resisting drought.

It has now become the most popular variety in the States of Wisconsin, North Dakota, Montana, portions of Idaho, South Dakota, and Minnesota. In one instance in Wisconsin, from the planting of 33 grains in the spring of 1899, there resulted a production of about 20,000 bushels in the year 1903, and a half million bushels in the present year, 1904. It is expected that the present year's crop will show that about 4 million bushels of this oat are being produced in Wisconsin. Although the highest legal weight of oats is 36 pounds to the bushel, this variety commonly weighs from 40 to 44 pounds in the Northern States, and occasionally reaches from 48 to 50 pounds to the bushel.

SPECIAL WORK ON COTTON.

The Bureau of Plant Industry has made a special effort to aid the farmers of Texas, Louisiana, and other Southern States where the Mexican cotton boll weevil has already appeared or is likely to appear. In all sections the energies of the Bureau have been put forth to encourage better methods of farming, with highly gratifying results.

COOPERATION WITH FARMERS.

With a view to bringing directly home to the farmers of Texas and Louisiana, especially those in the boll-weevil districts, the advantages of better methods of cultivation, the value of early maturing seed, etc., the Bureau organized an extensive line of propaganda work. The farmers in the various counties were organized and were brought into cooperation in such a way that large plantings were made under the direct supervision of the Department. Tracts of 5, 10, 15, and 20 acres were handled by individual farmers, under working plans furnished by the Bureau, the object being in all cases to demonstrate the practicability of growing cotton despite the presence of the weevil.

More than 5,000 farmers were engaged in this work, and the results have been highly satisfactory. At a recent meeting held in Houston, where more than 200 representative farmers from all parts of the State were present, records were presented showing the yields of cotton

under the plans of the Department compared with old methods. The increased yields, ranging all the way from 25 per cent to 100 per cent in districts badly infested by the weevil, show that by proper methods of culture, the use of early maturing varieties of seed, and the application of proper fertilizers excellent results may be obtained. A complete record of the yields from the various farms conducted under the direction of the Bureau has been kept, and a report embodying these data will soon be published.

COOPERATION WITH THE TEXAS AGRICULTURAL COLLEGE.

In the special work on cotton the Bureau of Plant Industry has been in the closest cooperation with the Texas Agricultural College. The president of the college has taken charge of the farmers' institute work, and with the aid of several men selected by him and men furnished by the Department all parts of the State were visited early in the spring, and the necessity for giving strict attention to better methods of cultivation was set forth. This institute work will be continued during the present autumn and winter. In addition to the institute work, the Bureau has been cooperating with the college in the matter of the breeding of cotton, the testing of fertilizers, and other important lines of investigation. Thorough harmony prevails, and every effort is being made by both the Department and college officials to make the work effective.

COOPERATION WITH LOUISIANA AUTHORITIES.

Cooperation has also been secured with the Louisiana authorities, and a number of important lines of work have been carried on in the State. The propaganda work, as described for Texas, has also been conducted in portions of Louisiana. Demonstration work with fertilizers has been carried on; also other investigations having for their object the encouragement in every way of better methods of farming in advance of the approach of the weevil.

DIVERSIFICATION FARMS.

As another feature of the work in the South, plans were made and put into operation establishing diversification farms at various places. The object of these farms was to show the value and importance of diversified agriculture. It was found unnecessary for the Bureau to expend any funds in the development of these farms, except in minor ways for the purchase of certain special seeds, and sometimes for special fertilizers where such were to be used. In all cases the business interests of the respective communities gladly cooperated with the Bureau to the end not only of securing a desirable farm for the purpose, but assuming all responsibility for its support. In every

instance efforts have been made in organizing these farms to make them not only self-supporting but profitable. The main object of the work is to show that by diversified agriculture the lands may not only be improved, but more money can be made than in farming with a single crop.

Thirty-two of these farms have been or are about to be established, of which 16 are in Texas, 5 in Louisiana, 3 in Georgia, 2 in Alabama, 3 in Mississippi, 2 in South Carolina, and 1 in Florida. The general method employed in locating, organizing, and conducting these farms is to first determine in what section of the State the various farms are to be located. An effort is then made to find a progressive farmer who is desirous of encouraging diversified farming in his section, and who is willing to permit the Department to aid him in doing it. When a suitable arrangement has been made, a representative of the Department and the State experiment station make a thorough study of local conditions with reference to cropping possibilities, markets, advantages, etc. A system of records is instituted, which enables the Department to secure detailed information regarding every phase of the management of the farm and the results secured. After the farms are established, other farmers are encouraged to visit them, this being done largely through the cooperation of the State experiment stations.

BREEDING NEW TYPES OF COTTON.

Extensive work has been inaugurated in Texas having for its object the breeding of new types of cotton better adapted to meeting the conditions brought about by the invasion of the weevil. More than 100 varieties of cotton have been grown and many selections have been made. This is necessarily slow work, but already very encouraging results have been secured in the matter of obtaining earlier and better yielding types—types that are better able to resist storms and types for special purposes in several regions.

DISCOVERY OF THE GUATEMALAN ANT.

During the year an important discovery was made by an officer of this Bureau, viz, the discovery in Guatemala of an ant that destroys the weevil. Eighty-nine colonies of these ants were brought into Texas and are now being thoroughly studied with a view to determining their value as a means of checking the serious inroads of the cotton insect. After the introduction of the ant by this Bureau further work on its distribution, habits, etc., was placed under the Bureau of Entomology.

WEEVIL-RESISTANT COTTON.

Another and perhaps more efficient method of combating the boll weevil than by means of the ant has been discovered very recently.

The hope of finding a variety of cotton not subject to injury by this pest has been cherished for several years, but hitherto no method has been ascertained by which the plant could offer effective resistance to the insect. It has been found, however, that in some varieties of cotton the presence of the larva, instead of blasting the buds and bolls, often stimulates a special growth of internal tissue which kills the young weevil. This is not merely accidental or abnormal, but is in the nature of a protective adaptation developed as a final result of a long struggle for existence between the cotton and the weevil in tropical America. The insect could not breed or perpetuate itself in the presence of a variety of cotton in which the formation of the new protective tissue occurred regularly. It is accordingly within the range of scientific possibilities that resistant varieties of cotton can be found in tropical America or developed by selection, and work on this line has been begun.

DISTRIBUTION OF EARLY-MATURING VARIETIES OF COTTON SEED.

With a view to encouraging the planting of early-maturing varieties of cotton, such as King and Parker, a large distribution of these varieties was made in the State of Texas and a portion of Louisiana during the year. Small quantities were sent to farmers, the cooperation of Senators and Members of Congress being secured for the purpose of distribution. Records have been kept of all the farmers who received this seed, and reports are now being returned to the Department as to its value as compared with ordinary sorts. In most cases very encouraging reports have been received as to the use of the early-maturing seeds, and the chief value of the work will be in the fact that from this distribution the farmers themselves may start the selection of stock seed for future planting.

INVESTIGATION OF THE COTTON ROOT-ROT.

As a feature of the work in Texas a special effort has been made to obtain information as to the best methods of combating the cotton root-rot. This disease has been very serious the past season, destroying large areas of cotton in many portions of the State. Efforts have been made to secure resistant types, but so far the results obtained have not been very encouraging, although some progress has been made. Experiments have been made for the purpose of determining the value of soil treatments, seed treatments, and other methods of combating this disease, including crop rotation. This work has just been started, and it is too early yet to determine its value.

PROGRESS IN COMBATING PLANT DISEASES.

CRANBERRY DISEASES.

Important advances were made during the year in the matter of treating cranberry diseases. The cranberry crop is an important one in this country, aggregating in value a million dollars or more annually. In recent years several destructive diseases have caused a great deal of damage, and until the Department began its investigations little progress had been made in the matter of treatment. Experiments the past year in the treatment of one of the most serious diseases, commonly known as "scald," have been quite successful. It has been demonstrated that this particular disease may be prevented by the application of fungicides at very small expense.

ERADICATION OF LITTLE-PEACH DISEASE.

The efforts made by the Department in the matter of demonstrating the feasibility of eradicating the little-peach disease from the orchards of Michigan and other States have been continued on a large scale. A section 3 miles square in Michigan was selected for this work and the orchards were thoroughly gone over three times during the months of July, August, and September and all of the affected trees were destroyed. The object of this experiment is to demonstrate what is believed to be a fact, viz, that the disease can be entirely eradicated by the extirpation process.

WINTERKILLING OF FRUIT TREES.

The extreme cold of the past winter caused the extensive killing of fruit trees in many portions of the Northern States. At the approach of spring the trees had the appearance of being seriously injured, and undoubtedly a great many would have been destroyed but for the timely aid rendered by the Department in the matter of suggesting proper means of handling such injuries. A brief report was issued as a guide to the owners of the frozen trees, and this undoubtedly saved many orchards from needless destruction.

DISEASES OF TOBACCO.

The most serious disease of tobacco in the United States during the past season has been the new malady called "wilt." This has been very destructive in certain portions of the South, and so rapid has been the spread of the trouble that it threatens the complete destruction of the large tobacco industry in North Carolina. Evidence is at hand that this disease is very similar to other wilt troubles, and that it may eventually succumb to treatment through the selection and development of resistant types. Work with a view to securing these types is now being conducted.

WILT DISEASE OF COTTON.

The success of this Bureau's wilt-resistant varieties of cotton was more marked last season than ever before. An improved selection from the Rivers cotton remained entirely free from the wilt on the worst infected land on James Island, South Carolina, where the finer types of Sea Island cotton are grown. These cottons, originating through the efforts of the Department, are not only wilt resistant but have a finer and better staple than the original nonresistant strains, thus disproving the assertion that resistance to wilt had been obtained at the sacrifice of quality. Considerable quantities of the seed of resistant and desirable strains of cotton have been obtained and distributed. In connection with this work the wilt of the cowpea has also been studied and resistant types secured and distributed. About 200 bushels of the resistant cowpea seed were sent out last spring. This work is being developed as an auxiliary to the cotton investigations, as it has been found that many thousands of acres of sandy soil in the Gulf States are infected by both the wilt and root-knot, and the cultivation of the ordinary cowpea results in great injury to the cotton.

ADVANCES MADE IN FORAGE-CROP WORK.

ALFALFAS AND CLOVERS.

Alfalfa has attracted more attention on the part of farmers in the eastern half of the United States during the past two years than any other crop. The Department has demonstrated that it can be grown in almost every State in the Union. Varieties have been found which withstand the rigorous winters of the northwestern prairie States. Other varieties have been found which are immune to the alfalfa leaf rust. There is still much to be learned concerning the adaptability of alfalfa to various types of soil in the Eastern States, and much time is being devoted to the solution of this problem. The cultural methods required for establishing and maintaining alfalfa meadows are also receiving due attention. The subject of clover sickness, a matter of very great importance to farmers throughout the clover region, is being investigated. New varieties of clover which appear to possess some advantages over the standard varieties grown in this country have been secured and are being propagated with a view to introducing them generally in the clover region as soon as sufficient seed is available. Some of our native clovers are being grown under farm conditions in order to determine whether or not they are worthy of domestication. One or two of them are promising, particularly for sections of the country where red clover does not thrive.

SOIL AND SAND BINDERS.

Methods of holding drifting sand in place have been thoroughly worked out. An agent of the Department has made a careful study during

the past two years of the methods which have been developed in Europe in work of this character, and demonstrations of these methods are now being made in portions of the country where drifting sand is most troublesome. Attention is also being given to plants adapted to hold banks and the sides of cuttings in place, and several plants which possess high value for this purpose have been found. This work is of particular interest to civil engineers, and in prosecuting it the most hearty cooperation from them has been received.

RANGE INVESTIGATIONS.

During the past year a large amount of information regarding the carrying capacity of the ranges in various parts of the West has been collected. The fact that intelligent management will bring the ranges back to their primitive state of productiveness has been established. For two years past an area of fenced range in Arizona, in which all types of range land are represented, from absolute desert to good mountain range, has been under careful observation. Two years' protection from stock has sufficed to make this range nearly as productive as it was in its virgin state. The methods of management used by parties who own or control considerable areas of range land are being studied. It is considered to be definitely demonstrated that there is no chance of improving range conditions except where stockmen are enabled to control the ranges upon which their stock feed, and data are being collected which will furnish valuable information as a basis for legislation concerning range lands. It has been demonstrated that a number of species of plants may be introduced upon the ranges by practicable means.

In nearly all cases the plants which have been of value for this purpose are annuals producing large quantities of seed. The possibility of introducing other plants upon the range is still being investigated. In this connection a careful study of the large collection of annual grasses from Europe in our extensive herbarium is being made, with a view to finding species which appear to be adapted to conditions on our Western ranges. Arrangements have been made whereby seed of some of the most promising of the species may be secured for use in the investigations of this subject. It has been demonstrated that in the mountain ranges where there is considerable rainfall a number of standard grasses and clovers may be established upon the range by methods that are entirely practicable. In the mountain region in the State of Washington, by protecting the range from the depredations of nomadic herds of stock, the Bureau has been able to establish such grasses as timothy, redtop, bluegrass, and white clover, thus adding enormously to the productive capacity of these ranges. During the year much assistance has been rendered to ranchers by outlining methods of handling their ranches.

THE CACTUS AS A FORAGE PLANT.

Much of the range country is covered with a sparse growth of cactus, which for the most part is looked upon by stockmen as a nuisance. During the past year a number of methods have been found by which the cactus plant may be utilized to advantage as stock feed. The value of the more promising species for forage purposes, the length of time required to mature a crop of cactus on land from which the old growth has been harvested, and the feasibility of establishing cactus plantations where they may be needed are now being investigated.

ALKALI-LOVING PLANTS.

The increase of the area of alkali lands in the irrigated districts of the West has given added importance to plants that may be grown upon such lands. Several such plants are available, and the Bureau is investigating the forage value of these plants, as well as methods required for their cultivation. A few years ago the Australian saltbush was shown to be adapted to lands of this character, and a great deal of interest in this plant was aroused among Western farmers. Recent investigations by the Bureau indicate that the cultivation of the plant has practically ceased. There is no question of the value of the Australian saltbush as a forage plant or of its adaptability to strong alkali lands. The principal difficulty with the plant seems to be that proper methods of utilizing it have not been worked out. The Bureau has undertaken to find what place it can be made to occupy in Western agriculture and the methods by which farmers can take advantage of its demonstrated value. Considerable areas of a number of other forage plants known to be adapted to alkaline conditions are being grown with a view to determining their forage value.

INVESTIGATIONS OF GRASSES, FORAGE PLANTS, AND STOCK FEEDING.

The office of Grass and Forage Plant Investigations is now in possession of the varieties of timothy developed by Dr. A. D. Hopkins. Some of these are greatly superior to timothy as ordinarily grown by farmers. They are being propagated with a view to making the seed available, which it is hoped will be within two more years.

Mr. A. B. Leckenby, director of the Eastern Oregon experiment station, has kindly turned over to this office 23 varieties of *Bromus inermis* secured by him during the past two years. These are being grown with a view to rendering the best varieties available for distribution.

The separation into varieties of such standard grasses as redtop, Bermuda, orchard grass, and meadow fescue has been undertaken. Work of this character already done indicates that all of our standard grasses are really mixtures of a large number of established varieties. Some

of these varieties are much superior to the grasses ordinarily grown. It is hoped within a few years to be able to offer farmers small quantities of seed of improved forms of all the standard grasses.

WEIGHT AND VOLUME OF HAY.

The office of Grass and Forage Plant Investigation has shown that the ordinary rules in vogue for determining the volume of hay in the stack are not reliable, and it has developed formulæ that give reliable results. It is now investigating the number of cubic feet of hay per ton for hay under various conditions as to kind of hay, size of stack, and length of time it has been in stack.

DOMESTICATING NATIVE GRASSES.

A considerable number of native American grasses have shown themselves to be adapted to regions where at present hay grasses are wanting. Several of these are being grown under field conditions during the present season with promise of success. The Bureau is gathering a considerable quantity of seed of other grasses this year and will give them a trial, particularly in the semiarid portions of the West, at the earliest opportunity. It is believed that hay grasses can be found for the Western plains where the average annual rainfall does not exceed 15 inches.

WINTER PASTURES FOR THE SOUTH.

It is estimated that during the past winter one-third of the range stock of some of the ranges in Florida perished for lack of proper nourishment. The winter being severe, losses of range stock were common in all parts of the South. It has been demonstrated that a number of plants can be made to furnish satisfactory pasture throughout the winter months in the South. During the past year a large amount of information concerning these plants and their adaptability to different soils, and the cultural methods required for their successful growth, has been collected. During the present season it is planned to cooperate with Southern experiment stations and Southern farmers in testing a number of these plants for winter pasture purposes.

GULF COAST CROPS.

The agrostologists of the Bureau are studying the forage value of the velvet bean, beggar weed, Mexican clover, and cassava for the region adjacent to the Gulf of Mexico, to which our standard forage crops are not adapted. They have shown that a well-nigh perfect stand of cassava can be obtained by germinating the canes in a cold frame or hotbed before planting them in the field. Heretofore the methods used produced ordinarily not more than half a stand of this crop.

Methods of keeping cassava canes over winter are still being investigated. These investigations indicate that the most important factor in keeping the canes is maturity. It is extremely difficult to prevent decay of partially matured canes during the winter months. Forty-two varieties of cassava have been secured, one of which last year produced seed in southern Mississippi, although planted nearly two months later than the best planting season. This year one plant was grown from this seed. It seems probable that some of these varieties may be made to thrive considerably farther north than cassava has yet been grown.

FORAGE CROPS FOR SOUTHERN FLORIDA.

The development of truck farming in southern Florida has rendered urgent the need of forage crops for the work-stock used on the truck farms and for the dairy cattle which supply milk to the numerous hotels. Feed for this stock is now shipped long distances at great expense. It appears that Guinea grass and Para grass are adapted to climatic and soil conditions in that section and their possibilities for this purpose are being investigated. Guinea grass seems to possess particular value for hay production, while Para grass appears to be promising as a pasture grass, particularly for wet muck soils. The Bureau is preparing to give them an extended trial.

PACIFIC COAST PROBLEMS.

The office of Grass and Forage Plant Investigations is searching for forage crops to grow in alternation with wheat in order that farmers in the great wheat regions on the Pacific coast may be enabled to secure more than one crop every other year on their fertile lands. A number of grasses are also being studied with reference to their adaptability to dry lands in that section, where there are many thousands of acres of land too dry for any of the standard forage crops.

JOHNSON GRASS.

The agrostologists of the Bureau have demonstrated that the formidable pest known as Johnson grass may be completely destroyed by practicable means and that it may easily be held in check. They are now making demonstrations of the methods developed in their investigations and are endeavoring to devise an implement for removing Johnson grass rootstocks from the soil.

SOILING CROPS.

With the development of stock farming and more intensive methods, particularly in the eastern half of the United States, the practice of soiling is becoming more important. Farm practice with reference to

soiling crops is being studied with a view to formulating systems for all sections of the country. In this, as in all investigations, the experience of successful farmers has been of great assistance.

CROPS FOR OVERFLOWED LANDS.

The problem of utilizing lands subject to annual overflow has continued to receive attention. Particular attention has been given to short-season annual crops, such as millet, early varieties of corn and sorghum, buckwheat, cowpeas, soy beans, and rape, for lands that are free from water during midsummer and the fall season, and all these crops have been grown successfully on land that was covered with water until the latter part of June. The native grasses which are extensively cut for hay on overflowed and swamp lands are also being studied with a view to making seed of some of the best of them available on the markets, so that farmers who are in need of such grasses may be able to obtain their seed.

FRUIT-MARKETING INVESTIGATIONS.

Next in importance to ability to produce choice fruits is the existence of a sufficient demand for them at prices that will yield a fair profit to the grower. In fact, without reasonable assurance of market demand for the product at fair prices, the planting or maintenance of commercial orchards or vineyards is folly. From the nature of their product, which is at the same time perishable and an article of luxury rather than of absolute necessity to the average consumer, the prosperity of our fruit growers is more dependent upon the price of their product at the time of harvest than that of almost any other agricultural class. Glutted markets at such times are peculiarly disastrous both to individual fruit growers and to the regions in which commercial fruit culture has become an important feature of agriculture.

The avoidance of gluts is, therefore, of very great importance to the entire fruit industry. While many remedies have been suggested, that which appears most practicable and reasonable is the wider distribution of the product. For this reason the chief line of investigation in fruit marketing has been the determination of methods best adapted to the harvesting, packing, storing, and forwarding of fruits to points relatively distant from their places of production, with a view to developing wider demand for them, both in the United States and foreign countries. Chief attention has been thus far given to problems connected with the development of the trans-Atlantic export trade, the most important work having been done with summer and winter apples, peaches, and pears.

While some important points are yet unsettled in connection with these fruits and require the continuation of experimental work upon

them, some gratifying evidence of the practical value of this line of work appears worthy of notice. The determination of the methods of handling and packing necessary to insure safe delivery of eastern-grown Bartlett pears in European markets during the season of 1902–3 was followed in the fiscal year 1904 by large and profitable shipments of this fruit from Eastern orchards to British markets. While official statistics are not available, it is known through commercial channels that more than 75,000 packages of this variety were thus exported, while the total shipments of Eastern-grown summer and fall pears amounted to at least 165 carloads. While this is but a small proportion of the entire pear crop, its removal from the domestic market was undoubtedly an important factor in maintaining the fair prices that prevailed in our markets during that season, notwithstanding the large crop of that fruit.

Largely through the efforts of the Department, which pointed out the way through experimental shipments which demonstrated the practicability of direct shipments of winter apples to French markets, an encouraging beginning in commercial shipments has resulted. Commercial estimates indicate that during the fiscal year 1904 our direct exportation of apples to France amounted to 200 carloads, which is about twelve times as much as the annual average of the preceding five years. With systematic and judicious continuation of such shipments until consumers become accustomed to American varieties and methods of packing, the French market should rapidly become an important factor in our export apple trade.

The most important experimental export work has been done upon winter apples, as the magnitude of the apple industry warrants first attention. A series of shipments to the principal European markets, in an effort to determine the relative value of the barrel and the box as export packages for this fruit, has disclosed on the whole very little difference in the net results where ordinary "No. 1" fruit was shipped, either with or without paper wrapping. These results are not considered conclusive evidence of the quality of these packages, however, as it is known that in such matters repeated tests are required to insure correct interpretation of results. Increased work along this line will be done during the coming year.

While exact determination of the effect of these investigations on the development of export trade can not be ascertained, it is interesting to note that a comparison of commercial estimates of the crops of the successive seasons with the exports of the corresponding fiscal years shows a steady increase in the proportion of the crop exported, as well as a large increase in the quantity shipped, the proportion exported having risen from less than 1 per cent of the estimated total crop for 1899–1900 to nearly $4\frac{3}{4}$ per cent in 1903–4, with a total of 2,018,262 barrels, valued at $5,446,473, in the latter year.

PROGRESS IN FRUIT-STORAGE INVESTIGATIONS.

The cold storage of fruit has grown to large proportions in the last decade, nearly 3 million barrels being cold-stored in the United States last year. When the Bureau began investigations along this line three years ago there was little exact information about the factors which influenced the keeping of fruit. It was popularly supposed that a cold temperature was the most important consideration in successful fruit storage, and that the frequent heavy losses were generally due to unfavorable storage conditions. As a result of the investigations, especially during the past year, it has been demonstrated that the condition in which the fruit is grown and the manner of handling it determine to a large extent the keeping quality as well as the ultimate value of the fruit. Fruit grown to unusual size, like that from rapidly growing young trees, from trees producing a light crop, or from trees forced unduly by tillage or by other orchard treatment, has been shown to deteriorate from one to three months earlier than the same variety grown more slowly.

The investigations are showing that fruit intended for storage must be handled with the utmost care in picking, packing, and shipping, and stored quickly after picking in well-ventilated rooms in a temperature of about 31° to 32° F., if the storage difficulties now most common are to be overcome.

During the past season the Bureau has undertaken to determine what factors cause the frequent losses that occur in shipping perishable fruits, such as peaches, to distant markets. From 5 to 30 per cent of decayed and soft peaches in the top layers of a refrigerator car on arrival at destination from the Southern peach areas is not uncommon, especially in moist, warm weather. Several cars in which the fruit was cooled quickly after picking to about 40° F. were shipped from Georgia to Northern markets. All of this fruit arrived in practically perfect condition, demonstrating that the common practice of loading perishable fruits in a heated condition is one of the important factors in causing serious economic losses. Furthermore, it was demonstrated that the cars could be loaded more heavily with little danger of the fruit in the top of the car deteriorating, and the fruit was harvested and reached the consumer in a riper and better condition on account of the better carrying quality.

In addition to the work outlined, the Bureau is endeavoring to supply the demand for information from fruit growers by determining what cold-storage systems are best adapted to farm use.

There has been a demand for experimental work in fruit marketing and storage from fruit growers on the Pacific coast. The funds available have limited the work to the East up to this time. During the present winter the investigations will be extended to the citrus indus-

try of California, which in the season of 1903–4 amounted to 30,000 carloads of oranges and lemons. The losses in transit and in warehouses when the warm spring weather sets in are sometimes very large. It is proposed to find out what relation the present methods of picking, packing, handling, and shipping the fruit bear to these losses, in a manner similar to the investigations with deciduous fruits.

That these investigations in fruit storage are having an important influence in improving the commercial methods of handling our fruit products is seen in their growing application by fruit growers, handlers, and warehousemen, all of whom are making demands on the Department for information and for enlarged investigations.

NEW PLANT CREATIONS.

The plant-breeding work, heretofore described, has been continued along a number of new lines. Great advances have been made in the matter of securing new and desirable long-staple cottons. During the last three years a number of long-staple Upland varieties of cotton have been originated, and these have come to be cultivated to some extent in certain parts of the cotton belt, and very generally in the rich bottom lands of the Mississippi and Red rivers in Mississippi, Arkansas, Louisiana, and Texas. A large number of hybrids have been made for the purpose of securing Upland types of long-staple cottons, which can be put into general cultivation, and which will be superior to those now in use. Several of these hybrids are approaching fixity of type. Among these are some having a staple from $1\frac{1}{4}$ to $1\frac{3}{8}$ inches in length.

In the breeding and improvement of corn important advances are being made. The main object of this work has been the selection of strains of corn best adapted to the different sections of the United States. The work is being conducted in cooperation with twenty or more State experiment stations and many farmers. Each year the Department obtains pure seed from the originators and breeders of the leading strains of corn in various sections of the country, and is sending this seed to different localties for comparative tests. At the same time extensive hybridization work is proceeding for the purpose of securing sweeter, more tender, and more productive strains of sweet corn for table use. Connected with this work, also, there are being studied problems relating to the handling of seed corn, seed selection, etc.

Extensive breeding investigations of oats have been carried on, mainly for the purpose of producing a profitable variety for the rich farm lands of the great corn-growing States, where oats are used in rotation with corn. The production of a more desirable oat for meal constitutes a part of this work. Some very promising hybrids have been obtained from the naked oat of China—the so-called "European hull-less oat."

In the improvement of potatoes important work has been conducted along two lines—(1) type selections, and (2) the production of new seedling varieties. This work was begun in 1902, and already very promising results have been obtained, especially from some of the hybrids.

Some of the most important investigations in the matter of breeding and selection have been inaugurated in connection with the growing of tobacco. This work is conducted along two principal lines—(1) the selection of individual types in the varieties, and (2) crosses between different varieties. Extensive work has been carried on in Connecticut, where both shade and outside tobacco are grown. The work conducted so far has shown unquestionably that the desirable characteristics in the leaf can be fixed from the first year's selection. In this work nine different types have been used and more than 300 selections have been made of each type. One hundred and twenty-five plants are used as a standard for each selection. Thus the work of selection alone has involved the use of something over 40,000 plants.

The work has been conducted in such a way that all the plants have been grown under tent shade, and the entire development of the leaf, from the seed bed to the manufactured product, can be followed. Allied with this work extensive investigations have been made as to the effect of hybridization. Hybrids are easily secured, and from the evidence already obtained by experience in the Connecticut Valley it is believed that the improvement of tobacco by crossing is practicable and can be successfully carried out according to plans now in operation.

Other important lines of work, having for their object the securing of new types of grains, fruits, and other crops, have been carried on. Important work has been done in the matter of developing new varieties of pineapples, new varieties of pears, and other fruits.

PROGRESS IN SEED AND PLANT INTRODUCTION.

The work of introducing and establishing new plants from foreign countries has resulted during the year in the introduction of 1,429 selected kinds of seeds and plants. These have been secured through correspondence and by means of our agricultural explorers, one of whom was sent to the Russian Caucasus in search of new varieties of fruits; one to the West Indies for tropical cassava; a third made an extensive study of the European flax regions, and a fourth visited Mexico in search of southern country apricots. Such a large number of plants, introduced during previous years, remained to be adjusted to American conditions that the efforts this year, more than last, were concentrated on the domestic side of the problems, and no very extensive exploring trips were undertaken. Notwithstanding this, however, a number of new important importations were made. A ship-

ment of over 350 date suckers, representing 42 varieties, mostly new to America, was made from the oasis of Biskra in the Sahara. Two hundred and seventy samples of different strains of European flax were collected. A collection of 19 selected varieties of grapes from the Russian Caucasus was arranged for. Two hundred and fifty pounds of seeds of the true pistache and smaller quantities of seeds of related species for stocks were imported from Turkey and Central Asia. Thirty-three varieties of mangoes of recognized superiority were secured from Central India in Wardian cases for Florida cultivators.

A shipment of 157 bushels of berseem was made from the valley of the Nile. Two thousand pounds of the famous pedigreed Hanna barley were secured from its originator in Moravia. Two hundred trees of the hardy Vladimir cherry, for trial in the Northwest, were imported from Russia. One hundred and five varieties of French phylloxera-resistant grapevines were secured for trial in infested California vineyards. New species of the lily, from the Philippines and the Neilgherry hills of India, were introduced for breeding purposes. The yang-taw, from Central China, an entirely new fruit-producing vine, was presented to the Department by Consul Wilcox, of Hankow. A number of promising resistant South African grapevines, a collection of Canary Island plants, some East African sorghums, and an interesting clover from Uganda were some of the gifts of Mr. Barbour Lathrop, whose expeditions in search of plants for this Department have been mentioned in previous reports.

Many of the important introductions from previous years still occupy the attention of the office, and either require fresh material from abroad or necessitate field experiments. The durum wheat area has been greatly extended, as already noted. A new date garden in the desert region of southern California has been established in cooperation with the State experiment station. The Egyptian cotton introductions are leading to the production of new hybrid races of promise. The Malin or Moravian horse-radish has proved a success. Japanese bamboo and Mitsumata paper plantations are being arranged for. Tropical mangosteens, imported by post, are being successfully propagated for distribution in Porto Rico and Hawaii. Egyptian clover is being given an extensive trial in Texas, Louisiana, and California. A new seedless pomelo from Siam has been grown for distribution. The Turkestan alfalfa has seeded in several localities, and the securing of American-grown seed of this variety is now a possibility.

CONGRESSIONAL SEED DISTRIBUTION.

As pointed out in my previous reports, constant efforts are being made toward the improvement of methods of securing and handling the general seeds for Congressional distribution. Improved appliances

have been perfected for the mechanical work, and improved methods have been adopted for securing the seed. The work is now all under the direct supervision of efficient officers of the Bureau of Plant Industry. Every effort is being made to improve the quality of the seed by securing pure stocks. Extensive work is being conducted in the matter of a critical study of varieties under different conditions of soil and climate. Testing gardens for this purpose have been established in a number of localities, and the work is under the supervision of a thoroughly competent expert horticulturist. Every effort is being made to encourage home seed growing. Practically all of the vegetable seed now distributed by the Department is grown in the United States.

A few years ago nearly all of the flower seed, except sweet peas, was imported. Now fully 75 per cent is grown here, through the encouragement offered by the Department in this work. A special effort is put forth in the matter of distributing promising varieties of cotton, tobacco, forage crop, and other seeds. The cotton experts of the Bureau have been constantly at work securing new and desirable sorts wherever they have been found in connection with the other cotton investigations. The results of this continuous distribution of improved strains are already beginning to show in a number of sections of the South.

In the handling of this enormous work which Congress puts upon the Department, the necessity for strict business methods has been fully observed. The work of handling one branch only of this problem involves the securing of more than 25 carloads of special seed, and the testing, packeting, and mailing of this large quantity to all parts of the United States. The systematizing of all the operations has been so perfected that there is little or no friction at the present time.

NITROGEN-FIXING BACTERIA.

Extensive practical tests were made the past season with nitrogen-fixing bacteria for use in connection with leguminous crops. The results have been even more successful than we had anticipated. Hundreds of applications have been sent in from every State in the Union for material with which to inoculate various crops. Practically all of these requests have been complied with in such a way that a record of the results could be obtained. The results show conclusively that where the organisms are used in accordance with the directions issued by the Bureau increased yields, ranging from 15 to 35 per cent, are secured. Furthermore, many farmers have been successful in getting stands of clovers and other crops on soils where failure has resulted heretofore. The several strains of bacteria sent out from the Department have proved valuable even on soils containing the uncultivated

organisms in abundance. It was discovered during the year that tubercle formation is not necessary to successful inoculation.

The bacteria can be present in the roots of legumes in a very efficient state with no tubercle formation whatever. The material for inoculating an acre of soil by the methods which have been developed costs the Department about 1 cent per acre and the farmer scarcely anything to apply it. So great has become the demand for this material that private concerns have become convinced that there is profit in preparing and distributing it, and several firms are now announcing their preparedness for doing this. Widespread interest in the subject has been manifested by the agricultural press and the magazines, and as a result of this propaganda work the demand for the organisms is constantly increasing.

INVESTIGATION OF PLANTS POISONOUS TO STOCK.

In parts of the Northwest where sheep grazing is an extensive industry, very great losses have been experienced in many sections, due to the so-called "loco disease." This disease is commonly attributed to the eating of the loco weed, by which parts of the range are almost monopolized. In one county in one of the Northwestern States in which sheep grazing has been the chief industry, the disease has made such inroads that many stockmen have been obliged to give up sheep grazing altogether, with the result that land values have depreciated and the sheep from this region are viewed with suspicion by buyers.

During the past two years investigations have been made to test the relation between this devastating trouble and the so-called "loco weed" prevalent in this section of the country.

FIBER PLANTS.

The textile industries using plant fibers have been growing, with increased demand for twine, cordage, and woven goods, but, with the exception of cotton, the production of plant fibers in this country has not kept pace with the consumption. The raw fiber imported during the fiscal year ended June 30, 1904, was valued at more than $47,000,000. This amount included about $9,000,000 worth of cotton, chiefly Egyptian and other grades, not produced here commercially. The other fibers imported were mostly sisal, manila, jute, flax, istle, and hemp. Investigations of all these fibers have been conducted by the Bureau, special attention being given to those likely to succeed in our own country.

DRY-LAND AGRICULTURE.

In my last annual report attention was called to the importance of developing a system of agriculture adapted to the semiarid areas of the United States where general irrigation for ordinary crops is not

practicable or possible owing to the small annual rainfall and the consequent lack of sufficient water. This is true of nearly one-fourth of the entire arable land surface of this country. It is believed, however, that a profitable system of agriculture can be developed for these areas by securing crops which will grow with a very small amount of water. Considerable progress has been made in this direction and facts have been secured which show the necessity of an immediate and thorough investigation of the conditions affecting the moisture requirements of crop plants for growth in semiarid regions, such as Kafir corn, alfalfa, drought-resistant wheats, and other crops at present unknown to American agriculture.

WATER PURIFICATION INVESTIGATIONS.

Attention was called in my last report to the investigations being carried on by the physiologists of the Bureau of Plant Industry with a view to finding methods of destroying obnoxious algæ in water supplies. The method discovered consists in using extremely dilute solutions of copper sulphate. After a chemical and microscopical study of the water to be treated, and identification of the contaminating organisms, the amount of copper required to be effective is determined and introduced in the form of sulphate. Numerous tests have been made in cooperation with boards of health and water engineers in a number of large reservoirs, and the method has proved remarkably efficient and successful. The fact that one part of copper sulphate to one hundred thousand parts of water will at ordinary temperatures completely destroy the bacteria causing typhoid fever and Asiatic cholera suggests the great usefulness of copper in fighting these diseases and other maladies caused by closely related organisms. Physicians and public health officials have taken great interest in this work, and will doubtless make prompt and thorough tests of the usefulness of copper in such cases.

CONSTRUCTION OF NEW GREENHOUSES.

The new buildings planned for the Department made it necessary to remove the glass houses now on the grounds. A special appropriation of $25,000 was secured for this purpose, and the new houses have been erected and are now complete. This new range consists of 8 modern houses, each 142 feet long, which were put up under contract. Three additional houses have been put up by the Bureau's force of workers, and two of the smaller houses have been moved from their old location to the new one. The new range is much more satisfactory than the old one, and it will be devoted to various lines of work connected with the Bureau. The contract for the new houses was let on June 1, 1904, and they were completed on September 1 of the same year.

ARLINGTON FARM.

During the year the important work of improving the soil conditions at the Arlington Farm has been continued. New systems of drainage have been put in, cottages for the superintendent and other workers constructed, barns erected, and other improvements made; and the farm has been put in shape for the advanced experimental work it is proposed to conduct there. Extensive plantings have also been made of economic fruits, ornamental trees, and other plants. Test work with potatoes, celery, forage crops, and various fruits has been carried on. Cooperative work with other bureaus has also been inaugurated.

COOPERATION WITH STATE EXPERIMENT STATIONS.

The Bureau of Plant Industry is now cooperating with practically all of the State experiment stations in the country. The work covers investigations of diseases of plants, studies having for their object plant improvement, investigation of forage crop conditions, encouragement in the production of new crops and new industries, and many other lines of work. In some special cases, notably California, close cooperation has been effected, having for its object the establishment of important testing gardens and other allied work. With the assistance of the officers of the California experiment station a testing garden has been established at Chico, Cal. The land for this garden has been donated to the experiment station, to be held in trust by the station for the use of the Bureau.

It is planned to carry on extensive work here in the matter of testing grains, fruits, and other crops specially adapted to the Pacific Coast. It is the policy of the Department in all cooperative work with the stations to fully recognize the relations of the stations to the officers who control them. Furthermore, wherever the Department desires to undertake work in a State, its policy is to endeavor to do this work in cooperation with the station.

FARM MANAGEMENT.

In order to properly conduct the work on farm management, which has already been set forth in previous reports, an office has been established for the purpose. The object of this office is to bring together in systematic shape all of the available information in the Bureau in such a way that it can be placed in the hands of the farmer for his practical use. The office gathers together information concerning farm practice in all sections of the country as a basis for further work. It secures and publishes correct records of crops grown and the manner of growing them, for the information of others who desire to

follow successful plans. It encourages farmers to visit and study experiment station work, the experiment stations, and the successful farmers in their own section. It encourages diversification in farming where continuous, clean cultivation of a single crop has impoverished the soil. It outlines systems of cropping for different kinds of farming in all sections of the country, and furnishes data in the matter of properly laying out farms, fruit plantations, truck gardens, etc.

BUREAU OF FORESTRY.

PRESENT FOREST SITUATION IN THE UNITED STATES.

The present outlook as regards forestry in the United States is exceedingly hopeful. The lumber industry as a whole is now awak ening to the fact that lumbering with reference to future as well as present profits may be good business and ought to be taken into account on business grounds. A growing tendency to hold cut-over lands is plainly marked among far-sighted owners of large holdings. This means that conservative management on the part of those who operate on a large scale is fairly launched. Except that further agitation is essential to give the facts publicity, the general adoption of forestry as an established policy now depends primarily on business conditions pure and simple. The question whether or not it will pay is one to be settled in each individual case by study of conditions on the ground. Forestry can not alter economic conditions; it can only use them. Forestry is now in actual practice on large, privately owned tracts in seven different States. This is the direct result of the past work of this Department in forestry.

FIELDS FOR FUTURE WORK OF THE BUREAU.

NEED OF INVESTIGATING GENERAL FOREST PROBLEMS.

Extensive investigations of forest conditions and of methods of operation are still urgently needed before the road to practical success can be said to be generally open. The employment of foresters by large private owners to supervise operations on their own lands is being taken up. In the public interest this needs to be brought about wherever conditions are favorable, but more and more the promotion of private forestry by the Bureau of Forestry can and should be made incidental to its other functions of directing the management of public forest lands and scientifically investigating general forest problems.

In the case of small owners much remains to be done. The farmers of the country are learning how to get the most out of their land in other ways through the scientific information which the Department of Agriculture collects and diffuses. So, also, in the case of timber yield, studies which individuals can not undertake but which must be

made if the wealth-producing power of the country as a whole is to be brought to its highest point, need to be prosecuted in the public interest. The average small timber-land owner is to-day in many parts of the country a a decided disadvantage in comparison with the large owner, because he lacks both working capital and equally broad knowledge of general conditions. It is true that large lumbering operations can often be made more profitable than small, but it is not in the public interest that small owners should fail to make a profit which is within their reach because they do not know how best to utilize what they have now, or do not realize what it is likely to be worth in the future. Thus the furtherance of that part of this Department's work which is directed toward informing the small owner how he can to advantage practice forestry on his own account, is of the first importance for the best use of the 200 million acres of woodlots which our country contains.

SCIENTIFIC STUDIES AND AID IN CARE OF STATE AND NATIONAL FORESTS.

By its scientific studies of American forests the Bureau of Forestry has prepared a solid basis for practical forestry. Special studies of our important timber trees have yielded information obtainable in no other way and essential to the management of forests of which they form an important part. There is now no considerable portion of the United States for which the Bureau of Forestry has not at hand special knowledge bearing directly on questions pertaining to the use of the forests. Nevertheless, what has been done is hardly a beginning in comparison with the vastness of the field.

In the work of building up a sound permanent policy for the forests of the National domain the Department of Agriculture has continued to render important services. Much of the work of the Bureau of Forestry during the year has been the examination of lands already reserved or likely to be reserved in order to recommend the exclusion from them of such areas as are more valuable for agriculture than under forest. The personnel of the Bureau of Forestry has become practically familiar, by studies on the ground, with every phase of the question of putting to the best use the public lands of the country. Thus an efficient force has been prepared by actual experience, as well as by technical, scientific training, for the demands which a fully developed National forest policy must eventually impose.

In the light of these facts it is plain that the ultimate function of the Bureau of Forestry as a part of the Government administrative equipment is gradually defining itself. Its effort to introduce forest management among large private owners at the earliest possible moment will cease to be necessary when it becomes generally successful. It was undertaken because of an evident urgent public need. Destructive lumbering had already greatly reduced the area of productive timber

lands in the United States, and its continuance was a menace to the future prosperity of the country. Because of the work of this Bureau forestry has now a recognized standing in the eyes of the American lumber trade. The Bureau of Forestry is giving a smaller proportion of its time to the preparation of working plans for large timber tracts belonging to private owners than ever before, and bearing a smaller proportion of the expense, and the progress of the past year has brought visibly nearer the time when it can withdraw practically or entirely from this field.

There will then chiefly remain work along the lines of (1) scientific study of problems which have a practical bearing on forest utilization for any purpose; (2) cooperation with States which ask advice concerning forest legislation, administration, or the formulation of a State forest policy, and (3) the discharge of whatever duties may be assigned to it in connection with the administration of the public lands by the National Government.

Along this latter line it is at present the official adviser in technical matters of the Departments which have in charge forested lands under Government control, both here and in the Philippines, and it is also chiefly responsible for recommending changes in present reserve boundaries and for recommending the setting aside of new reserves. The policy which lies at the base of the creation of the reserves is that the public forests should not be withdrawn from use, but should be managed under such restrictions as will insure their permanent usefulness. This policy this Department is actively furthering, and no part of its work is more important.

LINES OF WORK REQUIRING EXTENSION.

An increase in the funds available for the Bureau of Forestry is essential to make it possible to push its work more rapidly. It is my purpose to provide the fullest facilities for the prompt investigation of actual or proposed forest reserves, as well as for further examinations of forested parts of the public domain not now reserved which give promise of permanent value as sources of water or wood supply. The greatest need of the West is water. In many States future settlement and prosperity depend absolutely upon its conservation. This again largely, in many cases wholly, depends on the preservation of the forests. To make possible the execution and extension of the work, I have asked for an increased appropriation for the Bureau of Forestry for the coming year.

PLANTING ON FOREST RESERVES.—The work of planting on forest reserves opens another fruitful field. In the San Gabriel Reserve in California, the Pikes Peak Reserve in Colorado, and the Dismal River Reserve in Nebraska, the planting has been begun and should be vigorously prosecuted. In the first two cases the object is to cover

denuded mountain slopes with forest growth, in the interest primarily of water conservation and, in the case of the Nebraska reserve, to provide a future valuable timber supply. This planting is undertaken only after a careful preliminary survey has proved that there is an economic need for new growth which nature can not supply, and after painstaking experiment has demonstrated what methods can be depended on for success. Under these circumstances expenditure for planting is as truly economical as is that of the farmer when he purchases seed to sow that he may harvest the increase. I believe that an addition to the sum available for this work will be amply justified by the returns.

The development of economic mining will soon wait for the growth of trees within reasonable distance. The miner is an important factor in the growth of many of our States and of the country at large, and should have all facilities given him to conduct his work on the most economic basis. Where the miner ceases work the farm and factory lose a market. For this reason the miner should have the first claim on the forest for such timbers as he requires.

Studies in forest products.—Auxiliary to studies of the forest itself, but of the most importance in relation to the conservative use of our forest resources, stand the studies in forest products. Among them at the present time are (1) the studies in timber preservation, especially of railroad ties, which promise such conspicuous and successful results in timber economy; (2) the experiments in timber testing, to ascertain, under such conditions as obtain in actual everyday practice, new strength determinations for use by engineers, architects, and others; and (3) the investigations of the tannin content of barks, of pulp processes, etc. In the way of securing large economies by a comparatively small outlay for investigation, no more promising field for useful work by the Bureau of Forestry is open than this.

Cooperation with State authorities.—The desire of State authorities for the assistance of the Bureau of Forestry in cooperative work and in framing forest legislation and their willingness to contribute to its cost are facts worth noting. State cooperative studies have now been made in Maine, New Hampshire, New York, Maryland, Michigan, Wisconsin, California, and Hawaii. Were this Department prepared to push the work along this line large results could be rapidly secured. The whole cause of forest preservation hinges on the interest of the State governments, because no matter how fully persuaded the private owner may be that forest management promises to yield him good returns, without fair assurance of safeguard against fire and of equitable taxation during the period required for a second crop to mature on cut-over lands, he can make no headway. The exclusion of fire depends on local sentiment, State legislation, and State or local police and patrol. Unless the States are awake to their

duty toward this form of property the Federal Government can do little beyond caring for its own holdings. In California one result of the cooperative work now going on is the drafting of what appears to be the best forest-fire law yet drawn up in this country. The way is now open for a great advance through State cooperation if the requisite means of meeting its cost beyond the State contributions can be made available.

SUCCESS OF FORESTRY WORK.

The successive advances which have been made by Congress of recent years in the appropriation for the Bureau of Forestry offer one of the best evidences of the commendation which its work has received. More and more money has been given to it to spend because it has proved year by year its capacity to do more, and more practical, good work. It prosecutes its researches solely that it may discover and diffuse information which contributes to our National well-being. Within six years its force has increased sixteenfold and its expenditure twelvefold; but neither of these facts is an adequate measure of its advance in practical efficiency or of its success in changing former conditions. By a single discovery—that the cup and gutter system, devised by one of its agents, could be commercially applied to the production of crude turpentine—it is now saving many times more annually to the naval-stores industry than the total expenditures of the Bureau during the whole six years.

It has changed forestry for business returns in the United States from an undemonstrated and doubtful theory into a well-established business operation; it has converted the lumber industry of the country from an attitude of well-grounded suspicion to one of support; it has converted the general public from indifference to what seemed an impractical outcry to an intelligent comprehension of what forestry has to offer. By bringing home to the railroads the need of economic utilization, preservative treatment, and provision for future supplies it has set on foot a movement of incalculable importance. By teaching Western farmers how to plant and grow trees for farm protection and local timber supplies it has added materially to the comfort and prosperity of vast regions and many States. More important still, by demonstrating the capacity of the forest to store water, and by energetic activity to guard from sale or destruction forests of important protective power, it has contributed to the success of National irrigation, one of the most vital developments of recent years.

But though this Bureau has accomplished and is accomplishing practical results out of all proportion to its money expenditure, this is not exceptional in the Department of Agriculture, and forms in itself no justification for a further increase. The question is simply in each case whether the country will be better off by spending the money or

by not spending it. There are, however, certain special reasons why the Bureau of Forestry should have made, and should for some time continue to make, an exceptionally rapid growth. Its task is virtually that of building up a new science in this country, combined with that of getting its discoveries recognized and applied by a public once little alive to their value. No other branch of agricultural science has recently been in such need of development, and in the whole history of agricultural progress I believe that no other similar development was ever more timely. This development took place because of the unparalleled National need created by the vastness of the interest involved and the critical point which forest destruction had reached. And there is still much to be done before this new science can overtake the nation's requirements.

WORK ACCOMPLISHED DURING THE YEAR.

COOPERATIVE STATE FOREST STUDIES.

Forest studies in cooperation with State or Territorial governments were carried on during the year in New Hampshire, Maryland, Wisconsin, California, and Hawaii. A report on the work in New Hampshire is now in the hands of the printer. It contains a thorough study of the main forest resources of the State, and will afford a satisfactory basis for the adoption of a broad and far-sighted State forest policy.

The study in Hawaii resulted in the publication of a bulletin on "The Forests of the Hawaiian Islands," in the adoption by the Territorial government of its recommendations, and the appointment of a member of the Bureau of Forestry as superintendent of forestry in the islands.

A map and report embodying results of the work in Maryland will appear in the annual report of the State geologist.

In California over 20,000,000 acres of forest were mapped and described; the growth of planted eucalypts was studied; important investigations of the effects of chaparral cover on water conservation and on the forest, and of the forest replacement on denuded areas, were prosecuted; and the study of forest fires was continued, with the result that what is believed to be the best fire law ever prepared for State enactment has been drafted for presentation to the legislature.

FOREST MEASUREMENTS.

Of forest measurements there were handled during the last fiscal year the results of over 24,000 acres of valuation surveys, over 33,000 analyses of trees, 16,000 height measurements, and 2,300 taper measurements. The volume of this work does not, however, measure its importance. In computing, compiling, and digesting the mass of

information supplied by the field studies of the Bureau the accumulation of details would count for little if the results were worked up by purely routine or mechanical methods. The task imposed is to create a body of scientific knowledge by developing to significant conclusions the raw material turned in—a task calling first of all for intelligence and insight. The result is real advance in accurate knowledge of forest conditions and increasing ability to direct practical operations. Both in the preparation of working plans and in the special studies of commercial trees and forest problems which have been made during the year the efficiency of the work included under forest measurements has been demonstrated.

FOREST MANAGEMENT.

The work of the Bureau under the act of Congress of June 27, 1902, known as the Morris bill, has proved that conservative lumbering under practical regulations pays in the white-pine region of northern Minnesota. In point of fact a higher price was obtained for the timber sold under that act, to be cut and removed under rules prescribed by the Forester, than similar adjacent timber brought shortly before, when sold without such restrictions. On about one-fourth of the 200,000 acres to be lumbered the 5 per cent of timber to be left standing had been selected and marked at the end of the fiscal year.

During the year applications for assistance in introducing forest management on private holdings were received from 47 owners of large tracts, covering nearly 4,000,000 acres, and from 89 owners of woodlots with a total area of about 6,600 acres. The field work for eight working plans for large tracts, covering about 1,000,000 acres, was completed, and for 68 woodlots of nearly 19,000 acres total area.

The eight working plans for large tracts were studies of typical problems in five widely separated States. In Minnesota a tract of land formerly covered mainly with white and Norway pine, a large part of which has been lumbered and is now entirely unproductive, presented a characteristic example of much of the remaining forest land of the lake region. The plan of management devised provides for reproduction from seed trees and for fire protection. In Alabama a working plan was prepared for two forests of virgin longleaf pine, owned by one company, which wished to be assured of a continuous mill supply. In Texas another longleaf-pine study completed during the year furnished the material for estimating present and future yields of longleaf and at the same time demonstrated the wastefulness of some of the lumbering methods now commonly followed.

In West Virginia a tract covered with hardwood, hemlock, and spruce forest, much of which is in poor condition, was studied to ascertain the practicability of management. In New Hampshire three working plans were prepared: one for a tract where the requirement

was primarily the improvement of a forest-park property; the second for the tract of a manufacturing company wishing to secure a steady supply of box boards and increase the productiveness of the forest; and the third for a White Mountain tract, where the chief requirement was a system of fire protection.

Commercial tree studies of the year included balsam fir, paper birch, poplar, loblolly pine, and red gum.

DENDROLOGY.

Reports which mark the conclusion of the field studies of Missouri swamp forests and Ohio hardwood forests, and of the laboratory studies of gums, resins, tan barks, and pulp-wood fibers conducted in cooperation with the Bureau of Chemistry, were completed during the year. Field work was completed in the studies of California big trees and bristlecone fir, and of turpentine orcharding and laboratory work in a cooperative investigation of turpentine adulterants. A descriptive study of the forests of Suffolk and Nassau counties, Long Island, was begun and finished; investigations of Pacific coast tan-bark trees and of basket-willow culture were continued; and an investigation of methods of turpentine distillation, with special reference to improving commercial processes of production in this country, was begun. Experiments bearing on the culture of the sugar maple were made to supplement a study of the sugar-maple industry previously completed. The collection of forest photographs received notable additions by exchange with foreign countries, and by gifts as well as by the normal increase from the new photographs obtained by the Bureau of Forestry in connection with its field work.

FOREST EXTENSION.

In the work of cooperation with private owners to promote forest planting the Bureau of Forestry prepared during the year 42 planting plans for an aggregate of over 2,800 acres. Altogether 334 planting plans have been made for land in 52 States and Territories. This is a work of high utility, particularly in those regions of the West where timber and water are scarce and farm protection against hot or cold winds is important. Cooperation is confined to the giving of expert advice; all the expense of the planting is borne by the owner. By the adoption of a system of regional studies rapid progress is being made toward a point at which this expert advice can ordinarily be given by correspondence. When this point is reached, the Bureau of Forestry will be in a position to contribute materially to the well-being of wide regions at almost no expense.

In forest-reserve planting extensive operations are now under way in Nebraska, where previous experiments have pointed out how planting on a large scale can be made successful. In the spring of 1904

there were taken from the nursery and planted in the Dismal River Reserve 300,000 seedlings, of which over 90 per cent survived. Highly efficient and economical methods of doing this work were devised. Preliminary preparations for planting were made in the Niobrara Reserve, Nebraska, the San Gabriel Reserve, California, and the Pikes Peak Reserve, Colorado.

Studies of natural forest replacement were conducted in Colorado, western Kansas, western Nebraska, northern New Mexico, and New England.

The investigation of forest fires, with especial reference to methods of preventing and controlling them, has been continued, and encouraging progress made. The study of the reclamation of shifting sand through forest growth was continued.

FOREST PRODUCTS.

The studies in timber preservation conducted by the Bureau of Forestry are yielding results of large economic importance. Extensive experiments were conducted during the year in the West with longleaf, shortleaf, loblolly, lodgepole, and western yellow pine, spruce, and white and red fir ties. Ties were employed for these tests partly because of the opportunities for experiments of general application afforded by the selection of this form of timber, and partly because of the intrinsic importance of the specific subject of tie preservation. These experiments have already developed a number of important facts connected with timber seasoning and preservation.

In the Central States similar experiments were made with a large number of hardwood timbers, especially with those possibly capable of filling the place for certain uses of white oak and hickory, the supply of which is dwindling fast. It was found that chemical treatment will permit their use for structural purposes; that conspicuous improvement in present methods of seasoning is possible; and that the effectiveness of preservative treatment of red oak is greatly increased by thorough seasoning both before and after treatment.

In the East the seasoning of and application of preservatives to telegraph and telephone poles and cross arms were investigated, and discoveries which render possible considerable economies were made. Further experiments to reduce the rate of decay of poles at the butt are under way. Seasoning experiments are in progress with Adirondack hardwoods.

The investigation of the strength of timbers directly meets the needs of engineers, architects, and others who have to do with the use of construction timber, and is likely to be followed by a revision of specification requirements and grading rules. Large timbers in market forms and sizes, of red fir, western hemlock, and loblolly and longleaf pine

were tested. Eastern investigations of many species are needed in the interest of the most economical use of our timber supply; for it is undoubtedly true that timber trees neglected hitherto will be found to possess unsuspected value.

Other important lines of investigation pursued were a study of the mechanical properties of red gum, which established, among other things, its suitability for carriage manufacture; studies of the relative strength of various forms of tie fastenings and of devices to prevent the rapid wear of soft timbers protected against decay by preservative treatment; and a study of the effect of moisture content on the strength of timber.

LOUISIANA PURCHASE EXPOSITION FOREST EXHIBIT.

The most extensive and complete forest exhibit ever made by this Bureau was installed at the Exposition at St. Louis. It included the execution out of doors of tree-planting plans and the setting of trees adapted to every part of the country, and an exhibit of the best forest nursery methods. A full exhibit by transparencies, pictures, and apparatus illustrated every phase of our forestry work and forest conditions in all parts of the country. Methods of testing commercial timber were illustrated, and an experimental plant for wood preservation was established and operated during the Fair.

BUREAU OF CHEMISTRY.

The Bureau of Chemistry, during the last few years, has expanded the sphere of its activity in many directions.

AID TO OTHER DEPARTMENTS.

First to be noticed of this expansion is the work done under that authorization by Congress which secures the services of this Bureau for the other Departments of the Government. Under this authority the amount of work which has been done for the other Departments has rapidly increased. This is especially true of chemical determinations in collaboration with the Treasury Department.

For the Department of Justice extensive investigations have been undertaken to determine the injuries suffered by forest reserves from the fumes of smelters. For this Department, also, numerous chemical investigations have been made in connection with cases arising in the administration of justice in the Indian reservations and in certain cases of poisoning which have occurred within those reservations.

For the Post-Office Department extensive examinations have been made of canceling stamps and the inks used therewith; also of alleged remedies offered by advertisements through the mails and regarded by the postal authorities as fraudulent in their nature.

For the various Departments a large number of analyses have been made of articles offered under contract to determine whether these articles are of the quality and purity specified in the contracts.

FOOD INSPECTION.

The second important item in the expansion of the work of the Bureau of Chemistry has been the establishment of inspection for imported food products. Attention is invited to the fact that under this law the character of food products imported to this country has been greatly improved.

In former years the United States was regarded as the dumping ground for the refuse teas of the commerce of the world. Many years ago, in order to overcome this evil, a system of inspection of imported teas was established and has since been maintained. Under the beneficent working of this system Americans are now certain of being able to purchase pure and wholesome tea, since it is almost impossible for spurious and adulterated teas to find their way into this country. Congress has now extended this system of inspection to all foods, beverages, and condiments imported into the United States. There is every reason to believe that when this system is thoroughly established an improved condition comparable to that which has taken place in teas may be anticipated.

FOOD STANDARDS.

Another important advance which deserves special attention is that relating to standards of purity for food products. The Secretary of Agriculture has been authorized by Congress to fix standards, and in order that they may be just and reasonable he has been authorized to call to his assistance the experts of the Association of Official Agricultural Chemists and other experts, as he may see fit, to advise him in regard to such matters. The work of ascertaining these proper standards, in collaboration with the Association of Official Agricultural Chemists, has been committed to the Bureau of Chemistry. Already considerable progress has been made along this desirable line of investigation and a number of standards of food products have already been fixed by proclamation. It is proposed to extend this useful work until practically all the substances used by our citizens as foods, beverages, and condiments shall have a fixed standard of purity to which all manufacturers may attain by proper care in the preparation of products of this kind.

EXPERIMENTS WITH BORAX IN FOOD.

The work of the Bureau of Chemistry in the study of the effect upon digestion and health exerted by preservatives, coloring matter,

and other substances added to food has been continued in the same painstaking and thorough manner as in the preceding year. The great quantity of data secured in this work in relation to the effect of borax has been compiled and is now being published. These studies of the effect of borax have led to certain definite conclusions which are of the utmost interest to manufacturers of food products into which borax has often been introduced, and to the consuming public.

The effects of the preservatives upon the functions of the body have been studied in detail. It is admitted that there is a necessity for mineral substances in the blood, as they are essential to the functional activity of the various organs of the body, irrespective of any part they may take in direct nutrition. The necessity, for example, of saline solutions in the blood is known to every physiologist, but it is evident that these saline solutions can be derived from materials of common occurrence and naturally found in food products, or usually added thereto as condiments, such as common salt.

At the same time it must not be forgotten that this does not excuse the introduction of other soluble bodies which have a detrimental effect upon the functional activities, and the excretion of which imposes an additional burden upon the excretory organs. For although such substances might not impair the efficiency of these organs for a number of years, they would finally produce a condition of exhaustion which would be followed by serious consequences.

USE OF SMALL QUANTITIES AS PRESERVATIVE.

The argument that small quantities of deleterious substances may be used without harm is not logical, nor can it be based upon the result of the experiments which have been made. On the other hand, the logical conclusion which seems to follow from the data at our disposal is that the use of boric acid and equivalent amounts of borax should be restricted to those cases where the necessity therefor is clearly manifest, and where it is demonstrable that other methods of food preservation are not applicable, and that without the use of such a preservative the deleterious effects produced by the foods themselves by reason of decomposition would be far greater than could possibly come from the use of the preservative in minimum quantities. In these cases it would also follow, apparently as a matter of public information, and especially for the protection of the young, sick, and debilitated, that each article of food should be plainly labeled and branded, so as to show the character and quantity of the preservative employed.

EFFECT UPON HEALTH OF VARYING AMOUNTS OF BORAX.

The most interesting of the observations which were made during the progress of the experiments was in the study of the direct effect

upon health of boric acid and borax when administered in food. When boric acid or its equivalent in borax is taken with the food in small quantities, not exceeding half a gram (7½ grains) a day, no notable effects are immediately produced. The medical symptoms of the cases in long-continued exhibitions of small doses, or in large doses extending over a shorter period, show in many instances a manifest tendency to diminish the appetite and to produce a feeling of fullness and uneasiness in the stomach, which in some cases results in nausea, with a very general tendency to produce a sense of fullness in the head, which is often manifested as a dull and persistent headache. In addition to the uneasiness produced in the region of the stomach, there appear in some instances sharp and well-located pains which, however, are not persistent. Although the depression in the weight of the body and some of the other symptoms produced persist in the after periods, there is a uniform tendency manifested after the withdrawal of the preservative toward a recovery from the unpleasant sensations in the stomach and head above mentioned.

The administration of boric acid to the amount of 4 or 5 grams per day, or borax equivalent thereto, continued for some time, results in most cases in loss of appetite and inability to perform work of any kind. In many cases the person becomes ill and unfit for duty. The administration of 3 grams per day produced in many cases the same symptoms, although it appeared that a majority of the men under observation were able to take 3 grams a day for a somewhat protracted period and still perform their duties. They commonly felt injurious effects from the dose, however, and it is certain that the normal man could not long continue to receive 3 grams per day.

In many cases the same results, though less marked, follow the administration of borax to the extent of 2 grams and even of 1 gram per day, although in some of the cases studied the illness following the administration of borax and boric acid in those proportions may be explained by other causes, chiefly la grippe.

The administration of borax and boric acid to the extent of one-half gram per day yielded results markedly different from those obtained with larger quantities of the preservatives. This experiment, conducted as it was for a period of fifty days, was a rather severe test, and it appeared that in some instances a somewhat unfavorable result attended its use. On the whole the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand, it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of borac acid, for a limited period of time without much danger of impairment of health.

It is, of course, not to be denied that both borax and boric acid are recognized as valuable remedies in medicine. There are certain diseases

in which these remedies are regularly prescribed, both for internal and external use. The value which they possess in these cases does not seem to have any relation to their use in the healthy organism except when properly prescribed as prophylactics. The fact that any remedy is useful in disease does not appear to logically warrant its use at any other time.

It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period or when given in large quantities for a short period, create disturbances of appetite, of digestion, and of health.

TESTING OF ROAD MATERIALS.

The work of the Road Material Laboratory, now the Division of Tests, has been much broadened and its value and importance increased during the past fiscal year. The routine tests on road materials are carried on as usual, and several of the tests have been improved and standardized. The importance of testing rocks to be used in road building is being recognized at the present time by the leading highway engineers of the country, and a number of laboratories modeled after the Department Road Material Laboratory have been established in different places.

STUDY OF CLAYS FOR ROAD MAKING.

Of the 228 samples of road materials reported for the past year, 35 were clays. This is mentioned to show the high percentage which clay bears to the whole number of samples received; for it is a fact not generally recognized that in vast areas throughout the country clay is the only material of which roads can be built. For this reason much time has been spent in studying the physical properties of clays in the endeavor to devise methods by which they can be utilized in road making. It may be mentioned here that up to the present time but one method of using clay in road building has been known—that is, to mix it in the proper proportion with sand. This method, however, is not always practicable, for in many districts sand is difficult to obtain. Many of the Western railroads running through areas of the country where rock ballast was impossible to obtain have been in the habit of burning or clinkering clay with open wood and coal-slack fires along the line of their roads. This clinkered clay has been successfully used for some time past as a railroad ballast.

Many inquiries had been received as to methods of treating roads in some of the Western and Southwestern States, where, owing to absolute lack of hard materials and to the extremely sticky nature of the country clays, many of the farmers were absolutely cut off from the towns during the wet portions of the year. It was apparent that if the local clays could be cheaply burnt to a hard, dense clinker a

good road material could be provided. Preliminary to actual work on a large scale and expensive experiments on the ground, it was necessary to make laboratory tests of the clays to see whether they would burn to a dense, hard clinker. Samples of the well-known so-called gumbo clay were sent to the laboratory from the Yazoo district of Mississippi. These samples were experimentally burned in the laboratory of the Division, and it seemed quite possible to use the clays in the manner as indicated above.

Following upon this experiment, the Office of Public Road Inquiries built an experimental road in Yazoo City which has been reported successful. It is needless to point out the great importance of the success of such experiments in relation to road building in localities in which no rock is to be had.

IMPORT AND DOMESTIC PRODUCTION OF CLAYS.

Since it is shown by many letters of inquiry that information is being sought by people all over the country on the subject of testing of clays for the various purposes for which they are used, other than road building, special tests are now carried on to that end. A furnace has been installed and actual burning tests on clays are now made. In order to further stimulate interest in the development of native clay bodies, a special circular was issued on "The useful properties of clays." The aim of this circular was to give information in the simplest possible way to people who were not supposed to possess technical knowledge of clays. That the object has been attained is shown by the increased correspondence of the Division on this subject. The circular particularly points out that for the year 1902, the last year for which the official figures are available, the total imports of foreign clays to this country were valued at $1,154,805, while the domestic clays produced were valued at $2,061,072. Since the country possesses unusually fine clay bodies, a great many of which up to the present time await development, any stimulation of interest among the people to develop our native clays must be of great value.

CEMENTING POWER OF ROAD MATERIAL.

The satisfactory investigation of the important property of binding or cementing of road materials when used upon roads has been continued and much new evidence has been obtained.

Under the old rule-of-thumb methods of road building one sort of rock was supposed to be as good as another. Miles and miles of expensive roads have been built in a haphazard way, of any sort of material that was available, and many of such roads have "raveled" and gone to pieces almost as rapidly as they could be built. Since the establishment of the proper methods of testing and investigating these materials, there has been noticed a great improvement of roads. The most

intelligent and progressive of the State highway engineers are availing themselves of the opportunities extended to them by the Department of Agriculture for studying and familiarizing themselves with the physical properties of the materials which they are about to use before risking the public moneys in expensive work.

The hardness and toughness of a rock which is going to be used on a road are, as everyone knows, important properties, but the property which causes this rock under the influence of traffic to bind or cement together so as to form a smooth, even, impervious shell on the surface of a road is even more important. When the work of the Road Material Laboratory first began the importance of this quality had hardly been recognized, and absolutely nothing was known as to the reason why one rock should possess this property to a very high degree and another of perhaps identically the same name and species should be entirely lacking in it. The closest investigation has been given to this subject and to the collection of all possible data and information, not only from the theoretical and laboratory standpoint, but also from a practical point of view. It is safe to say that its satisfactory solution has been accomplished. A bulletin on "The Cementing Value of Road Materials" has just been published, and the publication of more work in the same line will follow shortly.

A new test for determining the toughness of rock and asphalt mixtures for road building was brought out during the past year, and several new tests are at present being developed.

CONCRETE FOR FENCE POSTS, ROOFS, ETC.

On the 1st of last July the Road Material Laboratory was made a Division, and its name changed to the Division of Tests. The object of this change was to establish in the Department a laboratory where all materials of construction relating to agriculture could be tested and allied problems investigated. In pursuance of this change, several lines of research have been taken up. The first problem selected was to determine whether or not a thoroughly practical concrete fence post reenforced with steel could be made sufficiently cheap to be used by farmers. The advantages of such fence posts would be many. The price of wood, particularly of the varieties used for fence posts, is continually rising, and even now the price is almost prohibitory in some sections of the country. Further, a properly constructed concrete fence post would be permanent, as it would neither rot nor undergo disintegration. A variety of methods of reenforcement have already been tried, and the experiments are being pushed as rapidly as possible. The results so far obtained have been most satisfactory.

Experiments of a similar nature to the above are about to be begun on methods for making concrete drains, watering troughs, roofs, and

barns, with the hope that concrete construction, so rapidly developing in the large cities, can be applied with benefit to the farm.

The question of the structure and constitution of hydraulic cements is a matter of the very greatest importance. The Division of Tests has in preparation a paper which I have good reason to believe will be accepted as the solution of this much-discussed question.

USE OF OIL ON ROADS.

Much interest has been felt in different parts of the country in the use of oil for treating the surfaces of highways, in order to lay the dust and to offer a hard, impervious, waterproof surface. It is well known that in California such treatment of roads has met with a high degree of success. Similar experiments, however, when carried out in the East, proved complete failures; the Eastern oil failed to bind on the surface of the road, and did not lead to the desired result. When it was found that the main difference between the California natural oils and the Eastern and Texas oils lay in the fact that the California oils contained an asphalt base, while the Eastern oils contained a petroleum or vaseline base, the Division of Tests immediately suggested that the cause of the failure of previous Eastern experiments was directly due to this fact, and road builders throughout the country were urged to make experiments with mixtures of crude oils with crude asphaltum. Last summer the Commissioners of the District of Columbia consented to make such an experiment. A street in Washington was selected for the purpose and a number of mixtures of Southern crude oil and asphaltum were spread in adjacent sections. At first the experiment was looked upon as a failure, but the road has been steadily improving, and at present there is every promise of the experiment proving a success. If it proves true that mixtures of Eastern crude oil and asphaltum make as good roads as the California oils do, a very great advance will be made toward the betterment of our rural highways.

SCHOOL FOR ROAD BUILDING.

One of the chief lines of work for this division during the present year is the establishment of a school of road building. The object of this school is to give a one-year course in highway engineering and the testing of road materials to about four young men who have received degrees from reputable engineering schools. These students are to be selected by a civil-service examination. They will devote six months to the study of road-building problems and road materials and six months to field work, which will consist of actual road construction. Men with such training are sure to be of the greatest service to the country, not only in constructing highways, but in disseminating accurate knowledge on highway construction.

BUREAU OF SOILS.

The study of soils and their management with regard to their values for producing crops has been continued. The composition of soils varies greatly in different localities and in quite limited areas. Our soils were nearly all fertile originally, but continued cultivation has in many cases reduced their powers to grow crops as they did when first brought under the plow. The best methods of restoring soils that have been cultivated too long is a pressing question not only in the older settled States, but is insistent in most of the newer lands of the West where wheat has been grown until profitable crops of it are no longer to be had.

Rotation of crops and laying down in pastures to be grazed until the soil fills with roots is the well-known restorative, but soils vary greatly in our several States and are adapted to the growth of special crops in our several latitudes, so that a general knowledge of their composition is of prime importance before the tiller can put them to their most profitable uses. Droughts limit the yield on soils that have lost their organic matter through continued cultivation without an adequate return of fertilizers in the shape of decaying vegetation. Commercial manures will not adequately remedy the evil, as they do not return to the soil what enables it to retain moisture. Soils vary so much in this regard, from coarse sand to retentive clay, that each requires careful study to enable the farmer to manage it to the greatest advantage.

The Bureau of Soils is mapping our various areas to the end that the residents on each may as soon as possible learn the peculiarities with which they have to deal. This work is comparatively new. Its value has been overlooked by the educator. A force of soil experts is being trained in the Department to help the cultivator to a better knowledge of the possibilities of his acres throughout our broad land, in order that run-down lands may be reclaimed and that the fertility of our newer lands may be maintained to meet the requirements of a rapidly increasing population.

We are bringing plants from all foreign countries to diversify our industries and enable our husbandmen to grow what has been and still is costing us large amounts of money. A knowledge of the character of the soils from which they come and on which they have been developed is imperative, and suggests to us the wisdom of becoming familiar with the soils as well as the climates to which we introduce them, if we are to maintain them here in their excellence or improve them, giving them better conditions than they had in the countries where we found them. Within the limits of our climates and soils we hope to improve everything we import through a superior aggregation of scientists who are making research into all the conditions of plant life, the soil being of greatest importance.

PROGRESS OF THE SOIL SURVEY.

The area surveyed and mapped during the fiscal year was 29,058 square miles, or 18,597,120 acres. The area surveyed during the preceding fiscal year was 23,293 square miles, which, together with the work done prior to that time, makes a total area surveyed up to that date of 74,795 square miles, or 47,868,800 acres.

The work was carried on during the past year in 68 areas in 33 States. On an average 20 parties have been working continuously throughout the year, in the Southern States during the fall and winter and in the Northern States during the spring and summer months.

The areas surveyed and the cost of the work in each area are shown in the following table:

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported.

State or Territory.	Work during 1904.	Work previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	2,396	1,223	3,619	2,316,160
Arizona	.....	611	611	391,040
Arkansas	626	251	877	561,280
California	1,679	3,921	5,600	3,584,000
Colorado	228	1,345	1,573	1,006,720
Connecticut	.....	518	518	331,520
Delaware	314	.....	314	200,960
Florida	485	548	1,033	661,120
Georgia	853	757	1,610	1,030,400
Idaho	58	1,077	1,135	726,400
Illinois	2,333	3,592	5,925	3,792,000
Indiana	889	387	1,276	816,640
Iowa	1,287	1,016	2,303	1,473,920
Kansas	999	464	1,463	936,320
Kentucky	.....	837	837	535,680
Louisiana	1,446	942	2,388	1,528,320
Maryland	29	2,634	2,663	1,704,320
Massachusetts	386	410	796	509,440
Michigan	517	858	1,375	880,000
Minnesota	.....	233	233	149,120
Mississippi	1,352	1,317	2,669	1,708,160
Missouri	1,111	919	2,030	1,299,200
Montana	.....	107	107	68,480
Nebraska	1,195	.....	1,195	764,800
New Jersey	.....	1,303	1,303	833,920
New Mexico	.....	129	129	82,560
New York	986	1,558	2,544	1,628,160
North Carolina	687	4,646	5,333	3,413,120
North Dakota	386	856	1,242	794,880
Ohio	1,400	1,355	2,755	1,763,200
Oregon	60	386	446	285,440
Pennsylvania	.....	1,204	1,204	770,560
Porto Rico	.....	330	330	211,200
Rhode Island	500	.....	500	320,000
South Carolina	1,159	2,032	3,191	2,042,240

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported—Continued.

State or Territory.	Work during 1904.	Work previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
South Dakota	.....	485	485	310,400
Tennessee	1,596	547	2,143	1,371,520
Texas	2,564	1,733	4,297	2,750,080
Utah	306	994	1,300	832,000
Vermont	227	.....	227	145,280
Virginia	656	2,747	3,403	2,177,920
Washington	.....	510	510	326,400
West Virginia	39	.....	39	24,960
Wisconsin	.....	955	955	611,200
Wyoming	309	.....	309	197,760
Total	29,058	45,737	74,795	47,868,800

RECAPITULATION.

Cost of field work	$64,238.36
Supplies	1,464.18
Traveling expenses between areas	4,115.55
Other expenses	2,783.32
Total cost of soil survey	72,601.41
Paid by State organizations	2,377.57
Paid by Department of Agriculture	70,223.84
Area surveyed ..... square miles	29,058
Cost of work in field per square mile	$2.21
Transportation, supplies, and other expenses, per square mile	.29
Average total cost per square mile	2.50
Average cost to Department of Agriculture per square mile	2.42

The cost of the work in the field has increased from $2.19 per square mile, reported last year, to $2.21 per square mile during the year just closed; while the average cost of the work to the Department of Agriculture, including all transportation, supplies, and office expenses, has decreased from $2.63 per square mile, reported last year, to $2.42 per square mile during the year just ended.

There has been a continued demand for this soil-survey work, and there are on file demands for about two years' work yet unfilled, while requests continue to come in which can not be immediately considered.

There has been a steady demand from colleges, experiment stations, and private enterprises for men trained in this soil-survey work, and during the past year several men have left this Bureau to accept more lucrative positions elsewhere.

PUBLICATION OF THE REPORTS AND MAPS.

At the last session of Congress provision was made to print in the form of "advance sheets" the several reports as they are prepared—500 copies for the use of each Senator from the State, 2,000 copies for the use of each Representative of the Congressional district or districts

in which the survey is made, and 1,000 copies for the use of the Department of Agriculture. Although this act was passed too late to materially influence the printing of the report of the work for the field season of 1903, it will very greatly facilitate the distribution of the report and is proving a very advantageous way for the printing and distribution of the report of the work for the field season of 1904, the manuscript of the first reports of which have already gone to the Public Printer.

ALKALI-LAND RECLAMATION.

In my last report attention was directed to the important results obtained in the reclamation of alkali soils by underdrainage and surface flooding. This work was undertaken as an object lesson to farmers in those irrigated districts of the West where any considerable trouble had been experienced with the rise of alkali and the consequent depreciation in the value of the land. The results of the past year have again proved the wisdom of inaugurating these demonstration experiments in alkali reclamation. Great interest in the work has been aroused on every side, and frequent inquiries have been received from farmers owning alkali land asking instructions as to the best methods to prevent the further deterioration of their lands and advice as to the reclamation of tracts now partly or wholly unproductive.

On the reclamation tracts established during 1902–3 much progress has been made during the past year, and indications point to the complete reclamation of the lands under experimentation at an early date. On the 40-acre Swan tract, near Salt Lake City, the results have been especially gratifying. At the inception of the work there, in September, 1902, a detailed soil survey showed the first 4 feet of soil over the 40 acres to contain more than 6,650 tons of soluble salts (alkali). In May, 1903, there had been removed in the drainage water, by actual measurement, nearly 50 per cent of this immense total, and in the October following the proportion removed had reached 82 per cent, thus leaving only 1,221 tons of the original 6,650 tons still in the 4-foot section of the entire tract. The greater part of the salt originally in the surface foot had been removed, while even the fourth foot had lost 69 per cent of the alkali originally present.

In the spring of 1904 this tract was sowed to oats, barley, and wheat, as it was believed to be sufficiently sweetened for shallow-rooted crops. The land was not in the best condition for seeding. Nevertheless, on many of the checks 90 per cent of a stand was secured, and on all checks but little evidence of alkali was observed. The flooding process was resumed on those checks having the poorest crop prospects, and will be continued on all the tract after harvest, and by next spring it is expected that reclamation will have progressed to such an extent that the deep-rooted alfalfa can be grown, when the land will be returned

to the owner. The growing of the crops of the present year and the seeding of the land to alfalfa are under the control of the Utah experiment station in cooperation with the Department.

The progress of a similar work on a 20-acre tract at Fresno, Cal., has been no less gratifying than that at Salt Lake City. The problem here as regards the drainage was more difficult, as the water had to be removed by pumping, while the soil was fine and silty and clogged the drain pipes. These difficulties have been surmounted, however, and within a year it has been possible to grow crops of alfalfa and wheat on a considerable part of the 20 acres under experiment. The Fresno work I deem particularly important, as it is situated in a wealthy district, where large areas of once productive land have been abandoned because of the rise of alkali and the swamping of areas by seepage water from the excessive irrigation of higher lying lands and from the canals.

In the Gervais tract, situated 3 miles from North Yakima, Wash., it is estimated that flooding from July to November, 1903, washed approximately 70 per cent of the total salts out of the soil to a depth of 4 feet. Here, as in the Fresno area, much valuable land has been ruined by seepage water and the rise of black alkali. Flooding of this tract was resumed in 1904, and it is expected that reclamation will have progressed to such an extent that crops can be grown in the coming season.

A more recent experiment has been instituted at Tempe, Ariz., where the installation of the drains was completed in February, 1904. An unprecedentedly dry season and a consequent lack of water have prevented much progress in the work at this point.

Another tract has been taken up for reclamation work near Billings, Mont. This tract is situated in the Yellowstone River Valley, where great progress has been made in growing alfalfa as a winter feed for the cattle and sheep that pasture on the adjoining mountain ranges during the summer. Shortly after irrigation began in this district alkali began to appear and the ground water rose rapidly, waterlogging wide areas of the land to such an extent that its cultivation had to be discontinued. An examination of certain parts of the valley, made by the Bureau of Soils in 1897 and 1898, showed the extent of the damage, and when, in 1902, a detailed soil survey was made around Billings it was found the trouble had greatly increased and intensified. Even in the two years that have elapsed since the survey was made, many fine alfalfa fields have been abandoned and now are heavily incrusted alkali flats. The farmers here are fully alive to the seriousness of the situation, but seem unable to cope with the problem.

Many tracts of land were offered the Department for the purpose of experiment, and a number of farmers have indicated their intention to undertake similar work themselves, showing the interest taken in

the work. This, however, has not proceeded far enough to permit a full report at this time. I have, however, the fullest confidence in the final success of the undertaking, as well as a firm belief that it will lead to individual or concerted action on the part of those of our citizens most interested, with the result that both the agricultural and stock-raising interests of this part of the country will be greatly benefited.

It seems, then, that within three years, at most, practically worthless land, so heavily charged with injurious salts as to be unfit for any form of agriculture, may be reclaimed to grow any ordinary field crop; that the method of doing this is simple; and that the expense involved is such that the work may in many instances be economically undertaken by individual, corporate, or State initiative. Taking the Utah tract for example, the land reclaimed has increased from a purely nominal value to an actual value, judged by the value of surrounding unaffected lands, of $250 to $300 an acre. The total expense of reclamation, taking everything into consideration, is but a small fraction of this enhanced value.

TOBACCO INVESTIGATIONS.

In the line of tobacco investigations carried on by the Bureau of Soils the most important work during the past fiscal year has been the experimental growing of Cuban seed tobacco on certain soils in Texas, Alabama, and South Carolina. This work was begun in July, 1903, in cooperation with leading farmers in the several States. Thirteen acres were planted in Texas, 3 in Alabama, and 3 in South Carolina. The success of this first trial led to further plantings by the Department in 1904, when trial tracts were established at Nacogdoches, Crockett, and Giddings, in Texas, a total of 12 acres being planted. One tract in Perry County, Ala., and one in Orange County, S. C., were established, each with 3 acres in tobacco. Samples of the tobaccos grown in 1903 were submitted to the trade, and the opinion is that the Texas leaf has considerable merit, both in regard to flavor and aroma, and some have pronounced it to be superior to any filler yet grown in this country. The Alabama filler leaf is considered fair, but not equal to the Texas leaf, while the filler grown in South Carolina does not meet with as much favor as that grown in the two States already mentioned.

The commercial value placed upon this leaf by different tobacco brokers varies considerably, ranging from 18 to 40 cents a pound.

Some bales of Texas leaf have been disposed of at the higher figure. Final judgment of the success of this venture must be postponed until further advices are received from the dealers and manufacturers to whom working samples have been submitted.

GROWING AND CURING CIGAR TOBACCOS IN OHIO.

Experiments in growing the Cuban type of filler have also been carried on on a 10-acre tract in Ohio. Owing to the heavy nature of the leaf it is impossible to judge of its aroma at present. The tobacco of this type raised in the preceding year is only just ready for the manufacturer. The aroma has been pronounced good, but it is believed that the leaf is too heavy for the taste of the general public and the aim this year is to try to produce a somewhat lighter leaf. The results of these experiments in growing Cuban filler leaf seem to warrant a continuation of the experiments in the Southern States and possibly in Ohio for the succeeding year upon somewhat broader lines; and it is hoped that through the efforts of the Bureau of Soils an extension of the domestic filler leaf interests may be accomplished.

By far the most important work in Ohio, however, has been the further introduction of the bulk method of fermenting cigar tobaccos. This work was begun in 1902, when 655,200 pounds were fermented. In 1903, 4,204,800 pounds were fermented, and in 1904 the quantity was increased to 10,208,000 pounds, distributed among the several types of tobacco as follows: Zimmer Spanish, 5,850,000 pounds; Little Dutch, 582,000 pounds, and seed leaf, 3,776,000 pounds. As the work of the Department there is simply supervisory, and entails the cooperation of the warehousemen, this great increase evidences the remarkable interest that this change in the methods of handling tobacco has to the grower and the tobacco dealer. Its use not only avoids great loss formerly suffered from fungous growth in the case-fermented tobaccos, but also tends to improve the grades of tobacco and therefore increase the profits both to the grower and the handler.

WRAPPER LEAF IN CONNECTICUT.

The experiments in the production of a wrapper leaf in the Connecticut Valley have been continued during the last year. In the beginning of these experiments in 1900, work was undertaken in cooperation with the Connecticut experiment station at Poquonock, on one-third of an acre of land. The tobacco grown on this small plot was submitted to leading leaf dealers and brokers in New York for their opinion. On their judgment, which was very favorable, the Department felt justified in conducting further work in Connecticut upon a considerably larger scale. In 1901, therefore, 40 acres were planted, this time in cooperation with leading tobacco growers in the valley. This tobacco was of satisfactory quality and was sold at Hartford, and although it had been grown under very unsatisfactory climatic conditions a very good price was obtained at the sale. In 1902 a larger acreage was planted by the Connecticut farmers; and leaf dealers of New York—men who had spent their lives in the tobacco trade and

who were everywhere recognized as good judges of tobacco—invested money in the production of shade-grown tobacco, not upon the reports of the Bureau of Soils, but on their own judgment of the satisfactory character of the leaf.

Owing to unfavorable climatic and adverse trade conditions, which were entirely beyond the control of the grower, the tobacco produced during that season failed, to a certain extent, to meet the demands of the manufacturers. The climatic conditions in 1903 were very similar to those in 1902—that is, they were unfavorable to the production of a wrapper leaf of the very best grade, and there was not so large a demand for this tobacco as was expected. In 1903 the Bureau had practically ceased its work in Connecticut; but in 1904, still having confidence in the opinion of the trade, and believing that the method of growing tobacco for wrappers under shade is correct, it has conducted an experiment at Tariffville, Conn., where a crop has been produced on a 4-acre plat. Owing to the recent tendency on the part of the trade to wrap the better grades of cigars with the Cuban rather than with the Sumatra style of leaf, 1 acre of this plat was planted to Cuban seed tobacco.

Tobacco of this type grown under shade in Connecticut was exhibited by the Department at the Louisiana Purchase Exposition at St. Louis, and to it was awarded the grand prize as being a leaf of the highest standard of excellence for cigar wrappers.

In connection with this matter of the producing of shade-grown wrapper in Connecticut, the Bureau of Soils has been making an investigation as to the demands of the market for the Cuban type of leaf and as to the practicability of building up a demand for Connecticut shade-grown tobacco of this type. Recent sales of this tobacco have been made, principally in New York and Philadelphia, and the following table shows the distribution of nearly 300 bales of such tobacco and the average price per pound of the lots as sold:

Prices received for Connecticut shade-grown tobacco.

For domestic use, 134 bales:			For domestic use, 134 bales—Continued.		
Bales, 17	per pound..	$1.75	Bales, 16	per pound..	$0.62½
1	do....	1.65	4	do....	.35
24	do....	1.50	For export, 144 bales:		
3	do....	1.45	Bales, 14	do....	.70
3	do....	1.40	30	do....	.32½
4	do....	1.35	100	do....	.30
60	do....	1.25	Tops, 104 bales:		
1	do....	1.00	Bales, 90	do....	.10
1	do....	.75	14	do....	.08

This table shows that 134 bales have been sold for domestic use at an average price of $\$1.26\frac{8}{10}$ per pound, the highest price being $1.75 per pound for light wrappers, and the lowest price 35 cents per pound for

short-sized second-quality leaf. The 144 bales sold for export, at an average price of $\$0.34\frac{4}{10}$, consisted of tobacco of a quality not suited to the home market, principally of sand leaves and short-sized, flimsy tobacco. Nearly all of this tobacco was shipped to the German market. The 104 bales, sold at an average price of $\$0.09\frac{7}{10}$, consisted of short top leaves, the tobacco having no wrapper quality, and being useful only as an inferior filler.

The tobacco experts of the Bureau of Soils see no reason to change their belief that the method of growing tobacco under shade in the Connecticut Valley will produce a wrapper leaf of great excellence, which can be economically used by the trade, and it would seem that the industry should be established upon a commercial scale.

IMPROVING EXPORT TOBACCOS.

Up to the beginning of last year the tobacco work of the Bureau of Soils has been along the lines of improving the methods of culture and handling of the cigar tobaccos, but this year considerable demand has been made upon the Bureau to assist the growers of the heavy export types of tobacco. The low percentage of tobacco suitable for plug wrappers, and the poor price obtained by the majority of growers, have led the Bureau to make investigations into the production of this type of tobacco, the object being to see if both the yield per acre and the percentage of the higher grades could be increased. A 5-acre experimental plot in Appomattox County, Va., was selected for studying the problem. In this section the finest plug wrappers are grown, and the work would also be carried on close to the Richmond and Lynchburg markets. It is the plan of these experiments to grow the tobacco with different fertilizers and under different methods of culture, to see which will give the best financial results to the grower. It is the intention of the Bureau to extend this work in the future to other districts producing the shipping types of tobacco. It is yet too early to give the results of the present season's work.

BUREAU OF ENTOMOLOGY.

Insect pests cause a loss to the staple crops of the United States estimated at some $500,000,000 annually. The main object of the Bureau of Entomology is to make thorough studies of the insects responsible for these losses and to apply the information gained to limiting or preventing them. The Mexican cotton boll weevil represents the most important field of work of this Bureau during the last few years, but the insect enemies of the cereals, fruits, and other staple productions have been the subject of careful study and experimental work. The results of this work have been notably successful, particularly in the case of the boll weevil and the bollworm.

THE MEXICAN COTTON BOLL WEEVIL.

Congress originally provided $30,000 for the continuation of the investigation of the boll weevil and the bollworm for the fiscal year.

DEMONSTRATION FARMS.

Under this appropriation seven experimental farms were organized in Texas, located at Victoria, Wharton, Austin, San Antonio, Calvert, Willspoint, and Hetty, all together aggregating 558 acres of cotton. The seven localities represented typical variations in soil and climatic conditions of Texas, and enabled the Department to test various methods of controlling the boll weevil under different conditions. They included bottom lands, dry upland subject to irrigation, the black prairie land of Austin, and the soils of river valleys where the presence of timber and moist climate and almost exclusive production of cotton renders the weevil problem more serious than elsewhere. Other farms were on the high, rolling prairie land and river bottoms of the northern part of the State.

The minute investigation of the life history of the weevil, upon the knowledge of which any system of control of the pest and any modification of the present cultural system must naturally be based, was continued at the laboratory at Victoria. In the experimental fields attached to this laboratory also were tested poisons and machines. An expert assistant carried on a study of the weevil in Cuba, one of its native regions, with the hope of finding some effective parasite or some variety of cotton especially resistant to its attacks.

The exact spread of the boll weevil into new cotton regions was determined, and a special investigation of the usefulness of birds in controlling the weevil was instituted. The result of the work of the season of 1903 is summarized in three important publications issued by the Bureau.

Under the provisions of the special appropriation of $250,000 made available January 15, 1904, it was possible to greatly enlarge the work.

The number of experimental or demonstration farms was increased to thirteen for the season of 1904, aggregating 1,077 acres. During the previous season in not one of the seven experimental farms then under operation did the crop fall appreciably below the average production in the United States before the weevil came into Texas, namely, about half a bale to the acre. The cultural system which these farms were designed to illustrate has so far proved to be the only practicable means of controlling the boll weevil, and the work of past years has demonstrated its general success and feasibility. It is the outgrowth of several years of field experiments conducted by the Bureau of Entomology in Texas. The cotton on these farms is planted under a contract which gives the Department complete control of the culture of the crop.

SCIENTIFIC AND LABORATORY WORK.

In addition to the conduct of these demonstration farms, the more purely scientific and laboratory work relating to the study of details of the life history of the weevil and of the possibility of artificial propagation of parasites has been increased. Special work has been done in the attempt to eradicate isolated colonies, to control the danger of dissemination of the weevil by the gins and gin products, notably cotton seed, and the perfecting of quarantine plans to check or prevent the spread of the weevil from Texas to other cotton-growing States.

COOPERATION WITH THE LOUISIANA BOLL WEEVIL COMMISSION.

The weevil having already crossed the line into Louisiana, the Bureau of Entomology has been doing cooperative work with the Louisiana boll weevil commission in eradicating colonies in Louisiana and preventing its further spread into that State, with the idea of protecting not only Louisiana but the more eastern cotton regions. The work of this year has been most successful so far as the experimental farms and other work in Texas are concerned. It has proved impossible to exterminate the weevil in Louisiana, its distribution in the western counties of that State having become already too wide. Nevertheless its spread has been very greatly checked, and by proper quarantine and exterminative work its eastern progress can be very much delayed.

COLONIZATION OF THE GUATEMALAN ANT.

The Guatemalan ant, which was discovered by Mr. O. F. Cook, botanist in charge of investigations in tropical agriculture of the Bureau of Plant Industry, and which seems to be a very efficient enemy of the cotton-boll weevil in Guatemala, has been the subject of careful experimental work, begun under the Bureau of Plant Industry and afterwards transferred to this office, but remaining under the charge of Mr. Cook. This ant, determined by experts of the Bureau of Entomology as *Ectatomma tuberculatum*, is a tropical species of rather wide distribution throughout Central America and northern South America. Its specific habits were unknown prior to its discovery in Guatemala, but in this region, according to Mr. Cook, it seems to be an important natural enemy of the boll weevil. Nearly a hundred colonies of this ant, representing some 4,000 individuals, were conveyed to Texas, and have during the summer been placed at different points, and are being made the subject of careful study to determine whether this ant offers any hope of control to any extent of the boll weevil under the climatic conditions of Texas. The practical results of this importation can not now be foretold. The ant has, however, maintained itself during the summer, which is a feature of distinct encouragement.

THE BOLL WEEVIL STILL A MENACE.

The future work against the boll weevil in Texas and other Southern States will depend upon the action of Congress. The National menace still exists. The cotton planters of Texas have not all become convinced of the benefit to be derived by following the advice which the Bureau is enabled already to give, based upon its investigations of the past ten years, and therefore further investigation and further demonstration work seem to be necessary. Moreover, the imminent danger of the spread of the weevil to other cotton States indicates the necessity that the General Government should keep a force of men in the field to prove to the entire satisfaction of the planters the value of its advice, to continue the study of the insect in its rapidly changing environment, and to assist in quarantine measures and such other means as are necessary to restrict the spread of the pest.

THE COTTON BOLLWORM.

The work on this insect, which is the second worst pest of the cotton and ranges throughout the cotton belt, has been continued during the last two seasons. The work during the season of 1904 has been much increased as a result of the special appropriation made available in January of this year. The principal lines of investigation followed out are field experiments in methods of control, and laboratory and field investigations of life history, habits, and parasitic and predaceous enemies of the insect. The field experiments have demonstrated that the cultural system of control recommended for the boll weevil furnishes the very best means also against the bollworm. The value of spraying and dusting with arsenical poisons and of trap crops was made the subject of careful experiments. This work was done on six contract farms over which the Department had absolute control, as in the case of the boll weevil, representing different localities and climatic and soil conditions. Cooperative work was also done at a number of other points, giving a total of some 400 acres on which experimental and demonstration work was carried on. The work outlined above has been most successful, and the Department is now able to recommend measures which will reduce damage from the bollworm to an inconsiderable amount.

In addition to these two principal cotton pests, other insects depredating on cotton, but of minor importance in comparison with these two, have been the subject of study.

IMPORTED BENEFICIAL INSECTS.

The possibility of keeping injurious insects in check by the introduction and encouragement of natural insect enemies of such injurious species is a very popular subject with fruit growers and farmers, and

notable successes have been achieved in this direction. The work in which the Department of Agriculture has been especially interested in this direction during the year has been a continuation of the effort to establish the Asiatic ladybird enemy of the San Jose scale in the Eastern States and the South African black scale parasite in California, together with the kelep or Guatemalan ant enemy of the cotton boll weevil, referred to elsewhere.

The Asiatic ladybird enemy of the San Jose scale (*Chilocorus similis*) maintained itself in numerous colonies in the South during the winter. An examination in Georgia in May last indicated the general presence of the beetle in many of the orchards where it had been liberated. Its rapid multiplication has been prevented, however, in many instances, by the submission of the orchards in question to spraying operations with lime, sulphur, and salt, or other washes, exterminating practically all of the scale food and hence leading to the starvation of many of the beetles. Nevertheless this imported insect has gained foothold and will probably make progress wherever scale food is abundant. Its spread by artificial distribution of colonies has been continued as far as material has been available. The discovery of the efficiency of the lime, sulphur, and salt wash, and the need in commercial orchards of absolutely clean fruit, will operate against this imported insect as against all other parasites of this scale. It is a comparatively easy matter and not expensive to keep an orchard clean by spraying, and while this is the case it will not be advisable in commercial work to take the slower chance of clearing up by natural enemies, which can never be thorough from the very nature of the case. The successful establishment, however, of this Asiatic beetle in America can not work anything but good, as it is an important agency in the control of scale pests, and will become more efficient in America as it becomes more widespread and abundant.

The black-scale parasite in California (*Scutellista cyanea*) has exceeded in usefulness the most sanguine expectations, and has demonstrated that it can withstand the winter climate of California perfectly. The black scale of which it is an enemy is the worst pest of the citrus industry in southern California, and this imported parasite is the first agency which has offered any real hope of control other than by direct spraying or gassing operations. As an illustration of the prolificacy of this parasite, more than 40,000 specimens were distributed from the office of the Los Angeles County horticultural commissioners, and vast numbers were distributed from other centers.

The older importations of beneficial insects, such as the enemy of the white scale of citrous and other fruits in California and the *Rhizobius ventralis*, useful against the black scale in the moist regions of the Pacific coast, have continued their rôle of distinct usefulness, the first named being the most striking case of benefit ever made by an

imported insect. The fig-fertilizing insect has enabled the raising of another very large and fine crop of Smyrna figs in the vicinity of Fresno, Cal., and the development of the fig industry seems perfectly assured, and only awaits the necessary lapse of time for new orchards to become established.

SCALE INSECTS.

The work with scale insects has been actively prosecuted during the year. This group of insects includes some of the most important enemies of fruit trees and shrubbery, and in the South also of various field and garden crops. The small size of most of these scale insects, and the necessity of making careful microscopic preparations of them before determination can be made, render their identification by field observers difficult, if not impossible. The result is that a great deal of the work of determination comes to this Department from State entomologists and horticulturists, as well as from foreign sources.

INSECTS DAMAGING FORESTS.

The work on tree pests is carried on in cooperation with the Bureau of Forestry. During the present year it has related particularly to (1) insect damage in the forests of the Black Hills region, a continuation of the work begun in 1902; (2) an investigation of important timber trees in the State of Washington, particularly the western hemlock, highland spruce, red fir, and other conifers; (3) at the southern station (Tryon, N. C.), damage to the southern pine and cypress; (4) in the middle Appalachian station, damage to imported mahogany and other timber and lumber by introduced and native insects, and to hickory, oak, and hemlock by bark-beetles and tan-bark insects; (5) at the southwestern station (Flagstaff, Ariz.), damage to pine forests by bark-beetles. In the course of this work there has been considerable cooperation with lumbering companies and manufacturers of articles of wood, importers of exotic woods, and forest rangers. The general information gained from this study and from laboratory work at Washington has greatly advanced the knowledge of forest insects and the means of controlling them.

INSECTS INJURIOUS TO VEGETABLE CROPS AND TO FRUITS.

The work reported in previous years has been continued in these two important fields of investigation. A subject of special study during the year has been the insect enemies of sugar beets, covering work done from Nebraska and Michigan to the Pacific Coast States and Arizona, with the object of issuing a comprehensive report on the subject. Work on the insect enemies of the orchard fruits, citrous and deciduous, and small fruits has been continued. The cranberry insects have been made the subject of a special publication.

MISCELLANEOUS WORK WITH INSECT PESTS.

A good deal of work has been done during the year in the study of means of controlling damage by insect enemies of stored grains, such as the flour beetles and meal worms, and particularly of the Mediterranean flour moth, one of the worst of mill pests, which has been reported during the year in many new localities, from New York to California.

Insects affecting shade trees and ornamental plants have been studied, as also the important insect enemies of hothouse plants and indoor cultures.

The investigation of insects in relation to the health of man has been continued. The geographical distribution of the yellow-fever mosquito in the United States has been the subject of special investigation, as having an important bearing upon quarantine measures.

A special study has been undertaken of rice insects in South Carolina in cooperation with the South Carolina experiment station.

INSECT ENEMIES OF GRAINS AND FORAGE PLANTS.

An elaborate investigation of insects affecting grains, grasses, and other field crops has been begun, and a special field agent of wide experience and reputation has been put in charge, with assistants and means for the best work. A further investigation will be immediately undertaken of the Hessian fly, the chinch bug, and the cutworms and wireworms and other insects affecting wheat, corn, clover, alfalfa, and similar crops. The damage by insects in this field is greater than in any other on account of the enormous areas under cultivation and the money value of the product.

EXPERIMENTAL WORK WITH INSECTICIDES.

The most important results confirmed by the experimentation of the year with insecticides relate to the use of the lime, sulphur, and salt wash against the San Jose scale. Experimentation with this wash, long used in California against this scale pest, has been going on in the East for several years, and the results now secured have fully demonstrated its very great value in spite of the somewhat adverse climatic conditions which obtain on the Atlantic seaboard and in the Mississippi Valley. It is a winter application, and very inexpensive as compared with the use of oils and soaps, means hitherto very much employed in the East, and it has the additional very distinct advantage of notable value as a fungicide; so much so in fact that some fruit growers are spraying their peach orchards with this wash, whether they have scale on them or not, simply for its value against

leaf curl and other fungi. The usefulness of this wash has very largely decreased the terror which fruit growers have hitherto felt for the San Jose scale.

The possible value of sulphate of copper as a means of controlling mosquitoes, as indicated in a report issued by the office of Vegetable Pathological and Physiological Investigations of the Bureau of Plant Industry toward the close of the year, caused a series of experiments to be instituted by the Entomologist to test the usefulness of this chemical as a means of destroying such larvæ. The results of these tests have shown that it has comparatively small value against mosquito larvæ under normal outdoor conditions of breeding, but it may prove to be quite effective against mosquitoes in regions where water is kept in cisterns or small storage reservoirs, as, for example, in Cuba and in Panama. The experimentation with this substance is still in progress.

An expert has been put in particular charge of all investigations with insecticides and machinery, and the opportunity for practical work has been very much increased. Experiments are now under way with the insecticides referred to above, and also with petroleum oils; also fumigation experiments on fruit stock and buildings and granaries, and work on the composition of insecticides in cooperation with the Bureau of Chemistry are being carried on.

ENTOMOLOGICAL EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION.

An elaborate exhibit of the work of the Bureau of Entomology was made during the year for the Louisiana Purchase Exposition—undoubtedly the most extensive and interesting exhibit ever sent out by this Bureau. It contains several entirely novel features of great educational value, and comprises very many cases indicating the life histories of injurious and other insects, together with large models of many of the principal injurious forms and vivaria in which injurious and beneficial insects are shown alive and at work.

SILK CULTURE.

The work in silk culture has been prosecuted in all available lines. Silk reeling has been practically established with imported French reels and the temporary employment of French experts. Several American women have acquired the art of reeling silk, and a beginning has been made in the training of experts in this line of work. The importation of eggs and their distribution to all applicants has been continued; also of mulberry cuttings and rooted plants.

As pointed out in my last report, the establishment of the silk industry in the United States must be a matter of slow accomplishment. The distribution of mulberry cuttings and of silkworm eggs to those

who already have mulberry trees at hand should be continued. Eventually enough mulberry trees will be planted to insure a supply of food for a large crop of worms. Numbers of people will also have become familiar with the methods of silk raising, and conditions will then be ripe for the establishment of commercial filatures. In the meantime and under the existing conditions the establishment of some sort of market for cocoons is necessary; and it is for this reason that this Bureau, out of its appropriations, is buying and reeling a crop of cocoons which, though small at present, will increase as the work progresses from year to year.

BEE CULTURE.

In bee culture comparative tests have been continued with the Caucasian and other types of bees and various crosses between these types themselves, in an effort to improve the domestic hive bee and secure certain varieties of special merit for different regions. The general conclusion reached is that the Caucasian race is by far the gentlest that has ever been brought to this country, and lends itself to manipulation and handling without the use of bee veil, and generally without smoke. These bees also are excellent honey gatherers.

The frequent statements that comb honey can be artificially manufactured have been shown to be absolutely false, and the purchaser who gets his honey in the comb may rest assured that he is getting an article manipulated at least by bees.

A special investigation has been made of bee conditions over a considerable area comprising the Middle West and Western States, with the idea to familiarize the expert with the conditions in these regions and to determine the feasibility and the desirability of the importation and establishment of foreign honey-producing plants.

A model apiary of 50 or 60 colonies of bees has been secured, and it is proposed to establish it on the Arlington Experimental Farm as a basis for apiarian investigations and as a breeding station of races and types of bees. The importation of foreign queens of different races has been continued, and studies have been made of honey-producing plants, methods of wintering bees, and bee diseases.

BIOLOGICAL SURVEY.

As heretofore, the work of the Biological Survey has been conducted along the three lines laid down by Congress: (1) investigations relating to the geographic distribution of animals and plants, including biological surveys and the determination of the life and crop belts; (2) investigations of the economic relations of birds to agriculture; (3) supervision of matters relating to game preservation and protection and the importation of foreign birds and animals.

GEOGRAPHIC DISTRIBUTION.

The Biological Survey is engaged in mapping the natural life zones and crop belts of the country for the primary purpose of aiding the farmer to decide what crops are likely to prove a commercial success in his locality. The work is done by studying the geographic distribution of native animals and plants in all parts of the country, and platting the results on maps showing the distribution of each species. In order to obtain the necessary data the status of the various species must be determined by office study and their ranges laboriously worked out in the field. The progress already made is gratifying, and a large number of maps are now approaching completion. The individual-species maps serve as the basis of a composite map showing the natural transcontinental belts and their more important subdivisions.

During the current year field work has been carried on over wide areas in California, Texas, New Mexico, Colorado, and Alaska. In California the field operations, for the purpose of securing data for a detailed map of the life and crop zones of the State, have been continued under the personal direction of the Chief. The field parties have practically completed work in western Texas, and are now in New Mexico. Explorations in Alaska have been continued among the northern spurs of the Rocky Mountains, about the upper and middle Yukon, and on some of the islands of southeastern Alaska.

ECONOMIC ORNITHOLOGY.

In the section of economic ornithology, as in previous years, both laboratory work and field observations have been carried on. Orchards, gardens, and grain fields have been visited for the purpose of determining whether the birds damage crops, attack injurious insects, or devote their energies mainly to the wild fruits and weed seeds of the neighborhood; and collections have been made of food materials, including wild fruits, berries, seeds, and insects to assist in the work of determination in the laboratory. During the current year examinations have been made of 2,189 bird stomachs.

In studying the food habits of California birds, with reference both to the damage they inflict upon fruit and the good they do in destroying noxious weeds and insects, a scientist spent seven months (February to October) in the State, interviewing many of the fruit growers and visiting the most important fruit-growing sections. Most of his work was in the orchards, where the actual mischief done by the birds was noted and specimens collected.

In cooperation with the University of California, a study was made of the restrictive influences exercised by birds upon the increase of the well-known and very destructive codling moth. As a result, it

was found that the pupæ of the moth are searched out and fed upon to a considerable extent by the black-headed grosbeak (*Zamelodia melanocephala*) and the Bullock oriole (*Icterus bullocki*)—two of the handsomest and commonest song birds of California. Other investigations were made in the same State regarding the supposed injury done by birds to bee keepers. Examinations of many stomachs of birds shot near bee-hives showed in nearly all cases that if bees are eaten at all the ones selected are the males or drones. A careful study of the food habits of the quail or bobwhite made during the year has demonstrated beyond question that from an economic point of view it is one of the most valuable of North American birds. Some of the insect pests eaten by it are the cotton boll weevil, potato bug, chinch bug, wire-worm, cut-worms of various kinds, and the cotton bollworm.

BIRD MIGRATION.

During the year the usual spring and fall migration schedules were sent to and received from the regular observers and filed for future use. Sixteen thousand notes relating to the migration of warblers north of the Ohio and Potomac rivers were selected and arranged to complete a bulletin on North American warblers. This bulletin is now passing through the press. Work was also commenced on a study of the relations of migration and the weather by comparing the time of spring arrivals with the temperature at the place of arrival and in the region to the southward.

GAME PROTECTION AND INTRODUCTION.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

Constant vigilance is necessary to prevent the introduction into the United States of birds or animals that are likely to become pests. No species, therefore, except a few that are well known and harmless, are allowed to enter this country without a special permit from the Department. And, as an additional safeguard, careful inspection is made whenever through the large size of the consignment or other cause there is any apparent danger that undesirable species may slip in. The permits issued during the year numbered 318 and allowed the entry of 1,470 mammals, 205,400 canaries, and 41,630 miscellaneous birds. Most of the canaries and a large part of the miscellaneous birds came in at New York and were examined by inspectors at that port. Several importations were made of birds intended for liberation, among them 65 capercailzie from Sweden, brought in at New York and destined for the stocking of Algonquin Park, Ontario; 40 Mexican quail, liberated at various points in California by the board of fish commissioners of that State; and 366 European song-birds—

goldfinches, bullfinches, larks, and robins—turned loose in British Columbia. Permits were also issued for the entry of about 3,000 eggs of partridges and pheasants.

INTERSTATE COMMERCE IN GAME.

Since the passage of the Lacey Act in 1900, 42 convictions for illegal traffic in game have been secured in cases passing through this Department. Of these, 26 were tried in Federal courts, 16 in State courts. During the past year 10 cases, involving the shipment of 700 birds and 36 rabbits, were reported to the Department. Six convictions were secured, one of which involved the longest distance shipment thus far taken up—from St. Paul, Minn., to Portland, Oreg. In order to expedite cases arising under the Lacey Act, State wardens have been advised to present their evidence direct to the Federal courts instead of referring it through this Department and the Department of Justice. This advice has been followed in two or three instances within the past few months, and indictments have been much more promptly secured in consequence.

Limited available resources have, as heretofore, made it necessary to concentrate efforts in two or three areas, and in all cases prevention of shipment has been given precedence over prosecution after shipment has occurred. The passage of laws by Texas in 1903, prohibiting sale and capture of waterfowl, made it possible for the first time to restrict the enormous destruction of ducks in that State for Northern markets. Through local authorities and express companies general attention was called to the provisions of the State and Federal laws and a close watch maintained on usual shipping routes. No violation of the law was noted, and it is probable few consignments of ducks reached Northern markets from this State during the year.

An attempt was made to ascertain the effectiveness of recent legislation prohibiting shipment and sale of game by means of a special investigation in cooperation with State wardens and others. The kinds and prices of game in the markets of a dozen or more important cities during Thanksgiving week were ascertained. That considerable progress has been made in enforcing shipping laws was conclusively shown; few prairie chickens were on sale in any Eastern markets, and in some instances prices three or four times as high as those of a few years ago were charged; pheasants were absent from the markets of several cities where they were formerly abundant; and at the opening of the season quail were unusually scarce, though later, when the routes of shipment still open were discovered by the trade, they became more abundant.

PROTECTION OF GAME IN ALASKA.

The Alaska game law has accomplished the two main objects for which it was enacted: The shipment of deer hides has been stopped

and the export of heads of big game as trophies has been curtailed. The protection of game has been as satisfactory as could be expected in so large a region and without wardens. A mistaken belief, however, that the law does not permit natives to kill game for food, coupled with objections to the presence of visiting sportsmen, particularly on the Kenai Peninsula, gave rise to considerable criticism of the law. This adverse feeling led to the introduction of a bill in the Senate to replace the present law with one doing away with all restrictions except a provision to limit the export of trophies and charge license fees of $25 to residents and $250 to nonresidents for such export. As the adjournment of Congress without definite action left this measure still pending, the Department deemed it advisable to suspend the issue of permits for the present except in very special cases. Early in June new regulations were issued extending some seasons, permitting unrestricted shipment of bearskins, and making other desirable changes.

MISCELLANEOUS WORK.

A preserve for the elk presented to the Government by Miller and Lux was established in Tulare County, Cal., on the Middle Fork of the Kaweah River, just within the boundary of the Sequoia National Park.

On the Pelican Island reservation in Florida a warden has been maintained through the cooperation of the American Ornithologists' Union and the Department, and the pelicans on the island have been practically undisturbed.

As heretofore, special attention has been given to the duty imposed by the Lacey Act of collecting and disseminating information relating to the propagation, uses, and preservation of birds. The demand for such information is widespread, and much time is devoted to gathering material and preparing it for publication.

RECOMMENDATIONS.

The three distinct lines of work assigned to this Division could be conducted much more economically and effectively were the Division reorganized as a bureau of three divisions, each to have charge of one of these lines, and were a larger amount appropriated for the performance of the work. I have accordingly recommended such reorganization.

BUREAU OF STATISTICS.

On July 1, 1903, the Division of Statistics of this Department, which is the oldest distinctively statistical agency of the Government, antedating by a score of years the creation of this Department, received the broader organization of a bureau.

As now organized the Bureau of Statistics includes a Division of Domestic Crop Reports, a Division of Foreign Markets, and a Miscellaneous Division, which conducts special investigations and collects statistics on rural economics. The work of the Division of Domestic Crop Reports forms the most conspicuous feature of the statistical work of the Department. It employs nearly two-thirds of the entire clerical force of the Bureau, and calls to its aid the public-spirited service of nearly 250,000 voluntary correspondents, whose painstaking service deserves grateful appreciation. The results of its investigations are published monthly in the Crop Reporter, of which over 1,300,000 copies were distributed during the year.

The general appreciation by the business and farming public of the value of the Department crop reports grows steadily. Criticism is not lacking. On the contrary, it is one of the curious features of this work that the more closely reports represent the actual facts and the wider the appreciation of their accuracy the more subject they become to criticism. This is undoubtedly due to the fact that as their general accuracy is more and more widely recognized they necessarily exercise a greater influence upon the markets, thus inevitably favoring or antagonizing, as the case may be, some of those who are engaged in the game of speculation in agricultural products.

This immediately attracts the adverse comments of the losers. This result is unavoidable, and is apparently the inevitable penalty the Department must pay for issuing reports so reliable and so generally appreciated as to have instant effect on the markets. Were the reverse true, and were these reports regarded as unreliable, they would not influence prices, and criticisms would be reduced to a minimum.

The Bureau is earnestly engaged in studying the efforts of numerous associations of cotton manufacturers organized in several European countries for the purpose of promoting the production of cotton in new lands, with a view to rendering them more or less independent of the American cotton grower. These efforts are being especially directed to the interior of Africa. Before long it is thought that the Department will be able to publish some valuable matter on this interesting subject.

The production and international movement of grain in the principal European countries is another subject which is receiving the earnest attention of the Division of Foreign Markets.

With the assistance of experts newly engaged, the rice and truck crops will for the first time be made the subjects of systematic and continuous statistical investigation. The grain belt has been redistricted and an additional field agent assigned to it.

OFFICE OF PUBLIC ROAD INQUIRIES.

Popular interest in road improvement appears to be deeper and more widespread than ever before. This is evidenced by the work of improvement actually going on in nearly all sections, by the State road legislation, by the calls for the road literature issued by the Department, and by requests for the advice and cooperation of the Department in building object-lesson roads.

COOPERATIVE FIELD WORK.

For greater convenience and efficiency in carrying on the field work of the Office of Public Road Inquiries the country has been somewhat roughly laid off into four main divisions, with a special agent in each. The work of these and other special agents in the field consists in collecting and disseminating useful information regarding roads and road building, conducting investigations and experiments, attending and addressing meetings, and representing the Department in cooperative object-lesson road work.

At several points in the South the Office of Public Road Inquiries has cooperated in the construction of experimental roads of a mixture of sand and clay, and the results have shown that, in the absence of stone and gravel, this mixture may often be used to great advantage. Other object-lesson roads were constructed, with the cooperation of the Office, in Arkansas, Ohio, Tennessee, Virginia, and West Virginia. These were in most cases first-class macadam roads. An especial effort has been made to keep accurate accounts of the work done in each case, and to report the operations and expenses in such detail as to make the work a source of instruction to all who may read the reports.

Reports from all sections of the country in which experimental and object-lesson roads have been built in previous years are unanimous in commending the character of the work done and testifying to its great influence for good.

It is intended that the work of the Office shall be continued along the present lines of helpfulness and extended so far as practicable, in order that its benefits may be most widely distributed.

STATE ROAD LEGISLATION.

The most important feature in State road legislation of recent years is to be found in the adoption of the State-aid plan. This plan involves a recognition of the fact that road improvement is a matter of general as well as local interest. The inefficiency of the statute labor system of repairing roads, the unwillingness of the rural taxpayers to assume the heavy burdens necessary to the building of improved highways, the popular aversion to the issuance of bonds, and the lack of any

central authority capable of coordinating the efforts of local communities, have to a great extent paralyzed efforts to secure general improvement of rural highways. The State-aid plan is intended to counteract these depressing influences. It provides sufficient funds to give scope and system to the efforts for road improvement; it distributes the burden of expense so as to greatly relieve the rural taxpayers; and it stimulates action on the part of local communities, coordinates local effort, assures competent supervision, and secures results of permanence and value.

The main features of the State-aid plan as now adopted in a number of the States are (1) a State highway commission, and (2) annual appropriations from the State treasury to pay a fixed part of the expense for building good roads, the balance of the cost to be met by the counties, the towns, and the owners of property lying along the improved roads. In nearly all cases the initiative is with the local communities, and the work is done under local control, but according to plans and specifications which must be approved by the State highway commission.

In New Jersey, the pioneer State in the adoption of this plan, the State pays one-third of the cost and the counties two-thirds, part of the county's share being assessed against the towns, the annual State appropriation being $250,000. In New York the State provides for one-half the expense, while the counties must pay 35 per cent and the towns 15 per cent. In 1903 the legislature appropriated $600,000 as State aid. No two States have adopted exactly the same provisions. Since 1890, eleven States in all have provided for a greater or less degree of State aid. They are the six New England States, New York, New Jersey, Pennsylvania, Delaware, and Maryland. In a number of other States the plan is receiving favorable consideration.

OFFICE OF EXPERIMENT STATIONS.

PROGRESS OF THE EXPERIMENT STATIONS.

The agricultural experiment stations throughout the country are maintaining close relations with this Department and are seeking its cooperation in increasing measure. The Department is endeavoring to aid the stations so far as it can with a view to raising the general level of their work in the directions of scientific accuracy and practical usefulness and to bring the results of their experimental inquiries promptly and effectively to the attention of farmers throughout the United States. It is believed that the Federal funds given to the several States for the maintenance of agricultural experiment stations are now spent more fully for useful agricultural investigations than ever before and that the results obtained by the expenditure of these

funds, combined with those contributed by a considerable number of the States, will compare very favorably in scientific thoroughness and practical effectiveness with the results obtained with equal expenditures of public funds for similar work elsewhere.

Under the system of State control of the planning and execution of the experimental operations of the State stations and under the liberal terms of the Hatch Act, through which the States are granted Federal funds for the partial maintenance of their stations, there is necessarily considerable diversity of opinion as regards the proper and wise expenditure of these funds. This fact is often overlooked in criticisms of the work of our stations as related to their use of public funds. With the growth of intelligent public opinion in the several States regarding the most useful functions of the experiment stations, the grade of their work has been raised, and when once the local constituency of a station has understood the real purpose and importance of good agricultural investigations, there has been little difficulty in securing the adherence of the managers of that station to the spirit as well as the letter of the laws under which the station is conducted.

ADVICE AND COOPERATION FROM THE DEPARTMENT.

It has been the effort of this Department to set before the stations a high standard of efficiency and to exert steady pressure for the improvement of their work. The cases of clear departure from the law in the use of the public funds granted under the Hatch Act have been comparatively few, and in such cases this Department has insisted on such an adjustment of expenditures as would protect the Federal funds. In most instances of this kind the stations have had funds wholly subject to State authority which could be spent more freely than the Federal funds and so have easily adjusted their accounts to meet the requirements of the Hatch Act. In some cases this has not been practicable and loss of a portion of the Federal fund of the ensuing year has resulted. Not a year passes but that some stations are persuaded by this Department to forego expenditures of the Federal funds which under the terms of the Hatch Act they might technically insist they had a legal right to make but which after discussion they are convinced are not in the best interests of their work. Especially has there been effected a more liberal interpretation of the duties and responsibilities of the agricultural colleges toward the stations, which are organized as departments of research in these institutions. There are now only a few of these colleges where the narrow and short-sighted policy of dealing illiberally with the experiment stations is maintained, and this Department will not cease its efforts to bring about a change of view and action by such college authorities on this important matter.

As the amount and variety of the cooperation between the bureaus of this Department and the State experiment stations increase there

arise from time to time questions of policy regarding the relations of the Department and the stations in such enterprises. To provide a regular agency for the discussion and adjustment of such matters, I have created during the past year a standing committee on cooperation, consisting of the Director of the Office of Experiment Stations and the Chiefs of the Bureaus of Plant Industry and Soils. Several conferences have already taken place between this committee and the executive committee of the Association of American Agricultural Colleges and Experiment Stations.

During the past year a movement looking to the increase of the funds granted by Congress for the use of the experiment stations has been inaugurated and legislation for this purpose is now pending. After a careful study of this matter in connection with the examination of the work and expenditures of the stations during the past two years, I am convinced that the demands on the stations for the extension of their work which have been aroused by their success in giving direct practical benefits to agriculture in all parts of the country can not be met without increased funds and that they are in a position to make effective use of larger means than they now have at their command. Now that this matter is being publicly discussed and the details of legislation have not been decided, it seems proper to state that in the view of this Department it is highly important that in any further act which Congress may pass for the benefit of the agricultural experiment stations the Federal funds shall be explicitly granted for purposes of agricultural research, and the powers and duties of this Department as related to the supervision of those funds shall be clearly defined.

STUDIES IN CHEESE MAKING.

As the work of the experiment stations advances from year to year experimental data accumulate in many lines, and from time to time results of great general importance come out of this extensive work. A good example of this at the present time is found in the investigations of the stations relating to cheese making. The importance of this in this country is shown by the fact that cheese production now amounts to 300,000,000 pounds a year, valued at approximately $30,000,000. Though cheese making is probably the oldest dairy industry, very little has been known regarding the principles on which it is based. For centuries it has been carried on largely by rule-of-thumb methods, and the reasons for the various processes and the exact nature of the changes brought about by them have been unknown to the cheese maker. He has been guided mainly by the traditions of his art and has depended upon the skill and judgment acquired through long experience.

Within the past ten years several of the experiment stations of this country have prosecuted systematic studies of cheese making with a

view of determining the principles upon which it rests and the means of simplifying and improving its processes. Owing to the large number of factors involved the work has been difficult, and for a considerable time the progress was slow. Now, however, the accumulated results are of great practical value, and it may be fairly claimed not only that this great industry has been put on a rational basis, but also that the art of cheese making has been simplified and its processes can now be more easily controlled, so that good cheese can be more uniformly produced.

GAINS IN USE OF FEEDING STUFFS.

The Office of Experiment Stations has recently published a summary of a large amount of work which the stations have done on questions relating to feeding stuffs. Some of the practical results of this work have been very important. The saving and use of corn fodder (stover), which was formerly so largely wasted over a large part of the country, is a striking illustration of this. Its value as a feeding stuff has been demonstrated, and the best means of utilizing it have been shown by the stations' work, and their continual agitation has brought about very great improvement in farm practice in this respect. At the nominal value of $1 a ton the corn stover crop of the United States would be worth at least $100,000,000. While it is not all utilized, much the larger share of it is, and the practice of doing this is steadily increasing.

The inspection of commercial and condimental feeding stuffs, brought about by the experiment stations, has already had the effect of largely holding in check the adulteration of these products and fraud in their sale. In a number of the States where the laws have been vigorously enforced by the stations inferior articles have been entirely driven out of the market, because farmers would not buy them unless they received the stations' stamp of approval.

THE AGRICULTURAL COLLEGES.

The activity of the colleges in providing special buildings and laboratories for instruction in the different divisions of the science of agriculture continues unabated. Among the buildings of this nature recently completed are the $50,000 agricultural building in South Carolina, the $150,000 agricultural building of the University of Wisconsin, and the agronomy and animal husbandry judging pavilion and the farm mechanics building of the Iowa State College of Agriculture and the Mechanic Arts. The University of Nebraska is erecting a $60,000 building for its school of agriculture.

The appropriations of the year for new buildings at the colleges and for the maintenance of these institutions have also been very lrgae. The State legislature of Virginia appropriated $165,000 for buildings,

equipment, and improvements at the agricultural college. The Iowa college has an addition of $50,000 to its maintenance fund, an appropriation of $95,000 to complete the central building, $45,000 for a dairy building, and $10,000 for equipping it, $22,000 for a new dairy farm, and $7,000 for equipment, and $54,500 to begin the construction of a heating plant, with several minor items, including $15,000 annually for the experiment station. The College of Agriculture of Cornell University is now definitely organized under State support, with an appropriation of $250,000 for buildings and equipment. The Illinois College of Agriculture has appropriations for a building for beef cattle, $25,000; another for horticulture, $12,200, and for a storage building for agronomy, $12,500. Minnesota has appropriations aggregating $300,000 for building purposes, including, among other items, $218,000 for a main agricultural building.

There is increasing interest in the formulation of courses in rural engineering and the provision of special facilities for instruction in this important subject. Special attention is being given to instruction relating to the construction and use of farm machinery. The continued scarcity of farm labor in almost all of the agricultural regions in this country makes necessary the employment of farm machinery on even a more extensive scale than has hitherto prevailed. The total value of implements and machinery on farms in this country, according to the last census, was $761,261,500, an average of $133 per farm and of 90 cents per acre of farm land. Much of this machinery is elaborate and complicated in construction and requires mechanical skill and genius for its most efficient operation and care. In very many cases it is also essential that the farmer shall understand how to repair such machinery. It represents an important part of the farmer's invested capital upon which he must earn or pay interest. That there is an enormous waste of money due to neglect and unskillful handling of this part of the farm equipment must be obvious to any one who has traveled through the regions where it is most used. The colleges can therefore do a very important work in training their students so that they will understand the construction, care, and most economical use of farm machinery.

The attendance at the land-grant colleges in 1903 aggregated 52,489 students, of whom 3,146 were in four-year courses in agriculture, and 7,550 in shorter courses in agriculture, dairying, horticulture, and veterinary science. The graduates of these institutions in 1903 were 4,524, and since their organization 53,252. The importance of the colleges of agriculture and mechanic arts as a part of the American system of higher education and research has been notably shown during the past year at the Louisiana Purchase Exposition, where an extensive exhibit of the work of these institutions was made in the Palace of Education.

SECONDARY AND ELEMENTARY SCHOOLS.

Progress has been made during the year along the lines of secondary instruction in agriculture not only in the schools maintained in connection with the agricultural colleges, but also in separate secondary schools, the number of which is steadily increasing. Considerable attention is being given of late to the practical instruction of women along agricultural and horticultural lines.

The introduction of agricultural instruction into the primary schools is being more widely discussed than ever before at meetings of teachers and farmers. The success of the nature study and school garden movement in a considerable number of city and country schools has led to a demand for the more formal teaching of elementary agriculture in the higher grades of the rural schools. The National Educational Association, State superintendents of public instruction, officers of agricultural colleges, as well as a number of other organizations and numerous individuals in various official positions, have of late interested themselves in the introduction of elementary agriculture and gardening in these schools. The National Educational Association now has a special committee of educators of national repute considering this subject.

METHODS AND TEXT-BOOKS.

At the recent convention of the Association of American Agricultural Colleges and Experiment Stations at Des Moines, Iowa, the standing committee on methods of teaching agriculture made a report in which it gave a brief history of the development of manual training and agricultural instruction in the common schools, and outlined a course of nature study and elementary agriculture for such schools. Outline courses in elementary agriculture have already been prepared by school officers in a number of States. These are supplemented by the formation of clubs of farmers' boys and girls, which are organized for the purpose of conducting simple experiments at their homes. Eight thousand Illinois boys belonging to these clubs exhibited corn of their own raising at the Louisiana Purchase Exposition. In a number of States laws have been enacted requiring teachers to pass examinations in agriculture, and the training of teachers along agricultural lines is already receiving considerable attention at agricultural colleges and schools, and normal schools, especially at sessions held during the summer. A considerable impetus to the movement for the introduction of agriculture in the public schools has been given by the recent improvement of text-books and works of reference. Within the last year or two a number of elementary text-books in agriculture have been published, and some of these seem well suited to use in the rural schools. In one way or another thousands of children in the

common schools are already receiving some instruction relating to agriculture, and the movement in this direction is rapidly increasing.

AID FROM THE DEPARTMENT.

This Department is aiding this movement so far as it can without having funds specifically for this purpose. It seems very desirable that the Department should be in a position to give more effective aid to the movement which contemplates the application of the results of practical and scientific investigations to our agriculture through instruction to multitudes of farmers' children in the public schools as well as in the agricultural colleges. The vast majority of teachers in rural schools throughout the country are unacquainted with the work and publications of this Department and do not understand how these publications might be utilized for instruction in subjects related to agriculture. Very much needs to be done to overcome the prejudice of school officers and teachers against the introduction of agricultural subjects into the schools. It is becoming increasingly clear that the results of the work of this Department and the experiment stations can not be most effectively and widely utilized by our farmers unless in early life they are taught to think and act along the lines in which the application of scientific principles and discoveries is made to appear theoretically rational as well as practically useful. Therefore, to secure the greatest benefit to our agricultural people through the expenditure of public funds in the maintenance of this Department and the experiment stations, we should be able to bring the work of these institutions directly to the attention of our educators and school managers in every State and Territory.

FARMERS' INSTITUTES.

Work in the interests of the farmers' institutes throughout the country has been regularly organized in the Office of Experiment Stations. Special efforts are being made to aid the large force of lecturers who are in the employ of the State directors of institutes. The attention of these lecturers has been definitely called to the numerous publications which this Department and the experiment stations are issuing, which will be useful to them in their institute work, and they have been put in the way of receiving these publications regularly.

There is also a growing movement for the establishment of the institutes in the several States on a more permanent basis. The form of organization most approved is that of a strong local permanent organization in each institute district, combined with a system of oversight and limited control by the central State authority, whose duties and powers are prescribed by law.

ALASKA EXPERIMENT STATIONS.

During the past year experiment stations were maintained at Sitka, Kenai, Rampart, and Copper Center, and cooperative experiments were conducted at Wood Island. Seeds of vegetables and flowers were distributed through the cooperation of the Bureau of Plant Industry to about 1,500 addresses. Many of the recipients report success and further confirm the possibility of raising hardy vegetables and hardy annual flowers in nearly all parts of the Territory south of the Arctic Circle. An investigation of the grasses and forage plants of Alaska is being conducted in connection with the Bureau of Plant Industry. At Sitka the headquarters building has been completed in accordance with the plans furnished by this Department, except for some minor alterations made in the interests of economy. More attention will hereafter be given at this station to horticulture and the propagation of trees and bushes for distribution to the other stations and over the Territory at large. Some nursery stock consisting of hardy and early maturing varieties of apples, plums, and cherries have been planted, and currants, gooseberries, and raspberries are also being propagated.

SOME RESULTS OF THE WORK AT THE STATIONS.

At the Kenai station about 21 acres have been brought under cultivation. Experience during the past two seasons at this point has shown that the maturing of grain is somewhat uncertain, though an abundance of forage can be grown every year. Cattle do well here, and the station is beginning in a small way to build up a herd.

At the Copper River Valley station, opened two years ago, a number of acres have been cleared and cultivated. During the season of 1903 barley and oats matured, and produced plump and heavy grain. Cultivated grasses seeded in experimental plats did well, and a considerable variety of hardy vegetables were grown. In 1904 an elaborate system of plants has been laid out and extensive experiments are under way with cereals. During August a severe frost destroyed many varieties of the cereals, rendering them fit only for hay, but some barley was matured and the grain saved for seed, and about 90 per cent of the Sixty Day and Finnish Black oats were matured, making about an average crop. This station has the first equipment of farm implements brought into the interior of Alaska. A number of small tracts have been cleared by settlers and are under cultivation at various points throughout the valley.

At the Rampart station grain matured in 1902 and 1903, and for this reason more extensive experiments have been conducted during the past year, and barley, oats, and rye have been successfully grown.

In general the experimental work in Alaska has shown that live

stock may be successfully maintained at many points in the Territory. The special agent in charge of the Alaska stations urges the desirability of securing breeds of sheep and cattle better adapted to the climate of Alaska than those which have hitherto been maintained there. It is, however, impracticable to carry on experiments with animals in any large way with the present funds at the disposal of the stations.

GRASS LANDS AND LIVE STOCK.

There are on the southern coast of Alaska, from Cook Inlet to Unalaska, about 10,000 square miles of grass lands, over one-half of which are capable of utilization. On much of this land there is a luxuriant growth of grasses often 6 feet high; on the remainder, lying at higher elevations and in more exposed situations, the grasses are too short for hay cutting, but furnish splendid pasturage. That these grasses are nutritious the fat and sleek condition of the cattle furnishes ocular demonstration.

At the present time this great resource is practically untouched, though there are small herds of milch cows at most of the towns and villages. Recently a live-stock company has begun operations with cattle and sheep on Kodiak Island and another company is making actual preparations to utilize Akutan Island.

It is possible for both sheep and cattle to live throughout the winter without care, as has often been demonstrated. Indeed, where cows belong to the natives they are forced to live through the winter with little or no care, eking out an existence by feeding on browse and seaweeds. Milch cows kept by whites are as a rule fed from five to six months, and this may fairly be considered the length of time when animals require feed and shelter.

Sheep raising has thus far not proved successful. The principal trouble seems to have been that the animals were of breeds not adapted to the conditions that prevail on the Alaska coast. In both cases where trials have been made grade animals were imported from the semiarid regions of California and Oregon, where the climate is well-nigh the antithesis of that in Alaska. With other breeds success is not at all unlikely to follow.

For three reasons I am impelled to believe that the Alaska grass lands as a whole can be most profitably utilized at present through dairying. First, because the small population of the Alaska coast limits the market for beef to a small fraction of the possible yield. Second, because of the necessarily long feeding period, five or six months, during which only dairy cattle will yield compensating returns. Third, because the freight to distant markets on concentrated products like butter and cheese is not a serious factor.

The Alaska coast furnishes many admirable sites for dairy colonies or settlements, both on the islands and on the mainland. With such a great wealth of grass as southwestern Alaska possesses it is difficult to believe that it will not become a great dairy country. It is doubtful if equally good opportunities for colonies of dairymen can be found in the United States to-day. Certainly there is no other place left where 320-acre homesteads of magnificent grass lands can be had for the taking. In view of the enormous area of these lands, it seems most advisable that this undeveloped resource be converted into wealth. Perhaps nothing will stimulate this as much as practical experiments and demonstrations by the Department of Agriculture.

HAWAII EXPERIMENT STATION.

A chemist and horticulturist have been added to the staff of the Hawaii station, and in this way the field of operations has been considerably widened. Soil investigations have been undertaken by the chemist, which are of general importance to the agriculture of the islands. The horticulturist has prepared a bulletin on bananas, which not only treats of the cultivation and marketing of this fruit, but also brings together descriptions of a large number of Hawaiian varieties, making possible a systematic study of this important food plant. Experiments are being continued on the cultivation and fertilization of bananas, and a large collection of varieties is being brought together on the station grounds. Experiments in the propagation of mangoes and alligator pears have been begun.

The entomologist has prepared a bulletin on the leaf hopper of sugar cane, which was investigated at the solicitation of many of the planters of the islands. This insect made its appearance quite recently and has proved in certain districts to be a very serious enemy to cane cultivation. The bulletin treats of the life history of the pest, describes the injury produced, and offers suggestions for its control.

Under the immediate direction of the special agent in charge, investigations have been made of some of the fungous diseases of coffee, sugar cane, and other economic plants, and a comparative test of grasses and forage plants has been begun in connection with the Hawaii Live Stock Breeders' Association. Cooperative experiments with tobacco have been conducted on the island of Hawaii with the object of producing a type of tobacco that is especially adapted to Hawaiian conditions. Cooperative experiments on cacao and banana cultivation are also being carried on in connection with the insular board of agriculture and the Hilo boarding school.

PORTO RICO EXPERIMENT STATION.

The work of the Porto Rico experiment station has been considerably enlarged during the past year, partly with the aid of an appropriation of $2,700 made by the insular legislature and nearly $1,200 received from the sale of farm products.

Many permanent improvements have been made on the station farm. A small tile machine was purchased and drain pipes were manufactured on the farm. Practically all the river bottom or alluvial land on the station farm has been drained. This is the first underdrainage ever undertaken in Porto Rico, and it is believed that it will not only greatly enhance the producing power of the station property, but will also serve as a valuable object lesson to the planters of the island. An experimental irrigation system has also been installed on this farm.

A preliminary survey of the principal tobacco districts of the island has been made by a tobacco specialist in the employ of the station, and a report on these investigations is being prepared.

The investigations on different methods of pruning, shading, and fertilizing coffee plants have been continued. An attempt to exterminate the coffee-leaf miner by hand picking the leaves proved the impracticability of this method of repressing this pest. The entomologist of the station has also been investigating the possibility of combating this insect by means of parasites, and reports the discovery of an effective parasite which, it is believed, by careful propagation and distribution, will aid very materially in keeping in check this insect, which is by far the most serious enemy to coffee cultivation now upon the island.

A special study of the diseases of coffee and other plants was made by the botanist of the Connecticut State experiment station, who was temporarily in the employ of the Porto Rico station.

Much attention is being given to the propagation of citrous fruits, especially with a view of obtaining better stock for growing in the orchards of Porto Rico. A bulletin on the methods of production and marketing of oranges, with special reference to Porto Rico conditions, has recently been issued. A large number of tropical fruits, including mango, alligator pear, soursop, nispero, guava, and many others, have been brought together in a tropical fruit orchard.

The tea, rubber, and cacao plantations mentioned in my last report are flourishing and are being extended. Among the tropical vegetables which enter into the variety tests are the yautia, taro, edible canna, arrowroot, cassava, yams, and sweet potatoes, all of which have thus far done well.

Experiments are being carried on with a number of fiber plants. Among these, maguey and sisal have thus far given very promising

results. The station has thus far conducted no careful experiments with cotton, but the industry has been extended throughout the island to a considerable extent during the past year, and the station officers report that the results seem to indicate that it is possible to profitably produce a medium grade of Sea Island cotton in Porto Rico.

The report of the Bureau of Soils on the soil survey from Arecibo to Ponce, made by that Bureau in cooperation with the Porto Rico station, has been reprinted in both English and Spanish for distribution on the island. Several other bulletins and circulars in both languages have been issued during the year.

PROPOSED EXPERIMENT STATION AT GUAM.

This Department has recently received a request from the governor of Guam for the establishment of an agricultural experiment station on that island. In making this request the governor states that the population of the island, consisting of about 11,000 people, and increasing at the rate of about 3 per cent a year since the American occupation, is devoted entirely to agriculture. The farms, which are small, are located in the hills back of the surrounding towns, and the people usually go to them in the early morning, returning to their domiciles at night. As they are devoted to tilling the ground and the raising of fruits, and to nothing else, this is an especially good field for the introduction of such additional fruits and vegetables as only the resources of the Government can command. The revenues of the island are insignificant, so that the people can not afford to pay anything toward an experiment station, although its influence will be very beneficial. There is a considerable tract in the public lands of the island which could be set aside for an experimental farm.

Since it seems quite important that the people of Guam should receive such aid in developing their agriculture as is now given by the Government to our other island possessions, I have recommended an appropriation of $5,000 for the maintenance of a station on this island in cooperation with the Navy Department.

NUTRITION INVESTIGATIONS.

In the nutrition investigations steady progress has been made in the elaborate and fundamental inquiries regarding the laws of human nutrition with the respiration calorimeter, and in the more directly practical studies of the nutritive value of cereals, fruits, and meat. The great importance of these investigations is being recognized, not only by scientific and educational institutions throughout this country, but also in many foreign countries. The constantly increasing number of requests for nutrition publications and for information from individuals, institutions, public schools, medical schools, and similar

sources, is a proof that the results of the nutrition investigations excite wide interest and are appreciated.

The cooperative method by which the work of investigation has been distributed among various educational, scientific, and similar institutions in the United States has been productive of as excellent results the past year as hitherto, and a satisfactory amount of investigation has been conducted. This has been made possible in part by the generous support accorded by the cooperating institutions, which have contributed in some cases money, and in practically all cases the use of laboratories, apparatus, libraries, the advice and counsel of skilled experts, and similar assistance. Other institutions have expressed a readiness to join in such researches, provided a comparatively small amount can be allotted them, but with the funds at our command it has not been found possible to extend the inquiry beyond the present limits.

CALORIMETER EXPERIMENTS.

The experiments with the respiration calorimeter during the past year have had to do principally with the comparative values of fat and carbohydrates as sources of energy. The apparatus has been so modified that a given quantity of air is circulated through the respiration chamber, the oxygen withdrawn by the subject being made good by the addition of a fresh supply, while the products of respiration are removed for measurement and analysis. This method of experimenting permits of direct measurements of the oxygen consumption in addition to other factors concerned with the metabolism of matter and energy, and represents a decided advance. In its present form the apparatus is fully as accurate as the form previously described and gives very satisfactory results. The form of apparatus which may be most advantageously used depends upon the character of the problem which is to be studied, since both the earlier type, in which a continuous quantity of air was pumped through the apparatus, and the present type, with the closed air circuit, furnish very accurate means of studying a large variety of problems which have to do with the fundamental laws of nutrition and practical questions connected with the satisfactory feeding of man and domestic animals.

SPECIAL STUDIES OF THE YEAR.

During the year the experimental and editorial work connected with the dietary studies at the Government Hospital for the Insane has been completed and a bulletin describing the results in detail has just been published. The data secured are of great interest in themselves and will prove of material assistance in formulating dietary standards and in other ways, while the experience gained in conducting investigations will prove of great value in future work of a similar character. The studies showed that the diet at the Government hospital

was well managed and that the food was abundant, of good quality, and well prepared. As the study progressed it became evident that in many ways economy in the preparation, handling, and storing of food might be introduced which would prevent waste and effect a considerable saving without making any radical change in the character of the menu. In other words, it was evident that, as in all business enterprises, more careful and expert management would prove valuable.

The studies concerned with the nutritive value and digestibility of flours of different grades have furnished very interesting data and the material now accumulated seems sufficient for answering the much-discussed question as to the comparative value of different sorts of flour ground from a given lot of wheat. It seems fair to say that the grades of flour known as whole wheat and graham contain a somewhat larger proportion of protein and ash than the patent grades, but are inferior as regards the thoroughness with which they are digested. Judging, therefore, by the total material which the body receives, the various sorts of flour are practically equal in value. The mechanical effect which the coarser flours exercise on the digestive tract should not be overlooked.

The dietary studies and digestion experiments with Maine lumbermen have given some interesting and valuable results. In fixing upon dietary standards it was desirable to have data regarding the kinds and amounts of food consumed by persons performing severe work and leading a very active outdoor life. Such conditions were met in the Maine woods. The diet with which the lumbermen were provided was comparatively simple in character though generous in amount. Generally speaking, the quantities eaten were fairly large, furnishing an abundance of both protein and energy. The food was quite thoroughly digested, no difference being observed between these men and those living and working under more usual conditions.

At the University of California, the investigations concerning the nutritive value, digestibility, and place in the diet of fruits and nuts have been continued and important data are being accumulated. The bulletins already published, which report the results of these investigations, have been widely circulated, showing that there is a popular demand for information along these lines. A popular bulletin has been published showing how a surplus fruit supply may be used in the household for the preparation of jams, jellies, and similar products, a class of foods which may be made to supply carbohydrate material in a palatable and attractive form, while at the same time the acids and other bodies which the fruits contain are believed to exercise a beneficial effect on the system.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

METHODS AND PROBLEMS.

During the past year the office of Irrigation and Drainage Investigations made a comprehensive study of the methods and cost of preparing land for irrigation. The results show the need of a better understanding of this subject by farmers. Much has been done by the Government and the States to aid engineers in the right planning of dams and canals, but farmers have not been aided in like measure in understanding how to get the best results out of the water when furnished. A bulletin published by the Department gives descriptions and illustrations of the tools used in grading land and building laterals and of the leading systems in use in distributing water in fields, orchards, and gardens. These studies show that the cost of preparing land for irrigation is far greater than has been realized, varying under flooding from $2 to $5 an acre and under the check system from $8 to $25 an acre. Here is a large opportunity for saving money to farmers by aiding them in choosing the method best suited to their conditions.

Last year a working agreement was entered into with the Western experiment stations for the systematic collection of information on important features of irrigation practice, which will enable this Department promptly and at small cost to collect and disseminate information of great practical value. This year the subjects studied were the methods of measuring water, the rate of rise of soil water during the irrigation period, and the use of cement and concrete instead of wood in irrigation structures.

DUTY OF WATER AND APPLICATION TO SOIL.

The increasing value of water has given added importance to the studies of its duty, which have been a leading feature of this investigation from the outset. Rights which originally were purchased for $5 an acre now sell for $35 an acre. Annual water rentals have risen in certain districts from $1 to $7 an acre. Every extravagant appropriation of water is a direct incentive to waste, and excess contracts and decrees will continue to be made so long as the quantity actually used has not been determined by accurate impartial measurements. This fact is giving the work of the Department increasing importance. Its reports are being used in fixing water-right decrees, and measurements of the duty of water on streams where adjudications are proposed, are urgently requested.

Scarcity of water in the arid West makes it desirable that it shall be used by irrigators in the most economical and skillful way. To aid in making this possible the Department is carrying on a series of scientific studies to determine the quantity of water which will give the

best results and the best method of applying it to crops. In one important irrigated district these measurements show that the quantity needed to irrigate 60 acres of land under the method in common use will irrigate 100 acres when applied by another equally feasible method. They also show that the time of irrigation and the quantity of water used have an important influence on the quality as well as on the yield of crops.

PUMPING WATER FOR CROPS.

During the past season records of the performance of over 2,000 irrigating pumping plants, scattered from Texas to Washington, have been obtained. These included many types of pumps operated by gasoline, crude oil, distillate, by steam generated by means of oil, coal, and wood, by electric motors, windmills, and water power. The rapid extension of pumping as a means of extending irrigation gives great practical importance to these studies.

Wind is one of the neglected but promising sources of power for providing water for irrigation and for doing other farm work. An arrangement has been made with the department of farm mechanics in the Iowa State College to supplement the field studies made during the year by more careful tests of the efficiency of different makes of windmills. The makers of these machines have manifested much interest in these investigations and have not only offered to supply the mills needed for testing free of cost but to manufacture others according to any special design suggested by this Department.

Last season's pumping studies lead to the conclusion that there is a broad field for irrigation by pumping; that where the lift of water is less than 50 feet the number of failures are comparatively few. The failures noted have been due to two principal causes: Lack of mechanical knowledge or skill on the part of farmers needed to keep machinery in proper condition; and the selection of pumps of too great or too small capacity for the work to be done.

IRRIGATION IN THE HUMID SECTIONS OF THE UNITED STATES.

The studies of irrigation in Italy show that irrigation is highly profitable in a region having a larger rainfall than the Mississippi Valley, and there seems no doubt that in a similar way it is to have a large field of usefulness in the eastern and southern portions of the United States. One of the special crops which require irrigation is cranberries, and a cooperative arrangement has been made with the experiment station of Wisconsin and the Wisconsin Cranberry Growers' Association, under which the Department is attempting to formulate the principles which should govern the irrigation and drainage of cranberry beds. The studies made in Wisconsin are being supplemented by similar studies in New Jersey.

In the rice districts of Louisiana and Texas practically all the water used in irrigation has to be pumped. The quantity used and the performance of different types of pumps in providing it are controlling factors in the success of this industry. Both these have been studied during the past year.

There is a large territory in central Arkansas which is believed to be well suited to rice growing. The Department is cooperating with the State experiment station to ascertain whether it will pay in this section to pump water to irrigate rice. The results this year, while encouraging, show that it will require considerable experimental work to place the industry on an assured basis.

DRAINAGE INVESTIGATIONS.

Crop production is being extended in this country in three ways—(1) by reclaiming, through irrigation and drainage, lands hitherto worthless or yielding only a nominal return; (2) by improving soil conditions in lands already under cultivation; (3) by scientific rotation and intensive cultivation of crops.

Since soil drainage is an important factor in all of these, the promotion of practical and efficient methods may do much for the general improvement of agriculture. Original investigation, combined with careful scrutiny of current practice in this and other countries, will enable this Department to place before State and district authorities, cultivators, and landowners the methods and practices suited to their conditions.

The following work was carried on during the year:

(1) An examination of some of the irrigated lands of Utah for which drainage is urgently needed, the giving of advice concerning plans, and the beginning of some experiments in tile drainage to determine the operation of underdrains in certain soils.

(2) The examination of several large drainage projects in the Middle West, in company with engineers, county boards, and interested landowners, followed by reports and recommendations of plans. About 400,000 acres of land are affected by these projects, with an estimated outlay for drainage of $1,000,000.

(3) Collecting and classifying field data upon the construction of levees for protection of river bottom lands; their ditching and drainage by pumps; construction, duty, and operation of land dredges; the construction and behavior of drainage ditches of various sizes.

(4) Collection of data regarding the operation of the older systems of tile drainage in the Middle West, with respect to determining how far conditions may be improved by reconstruction.

A preliminary examination of a portion of the Everglades in Dade County, Fla., was made in conjunction with the Bureau of Plant Industry, and it is thought that the Everglade soil can be made profitable for

growing subtropical fruits if it can be sufficiently drained. In view of the interest taken in growing fruit and vegetables in southern Florida for the Northern winter markets, the reclamation of the Everglades merits further attention.

The lines of work carried on during the present year indicate the widening importance of this branch of agricultural improvement. The condition of much of the farming land in the older irrigated districts, and especially in Utah, demands prompt and active relief through drainage, or the loss already suffered by bogging of the land will be rapidly augmented. The Department can render great assistance to the people of these sections by enabling experts to direct and assist in starting practical drainage operations in localities where farmers are ready to begin.

An entirely different class of problems has been encountered in connection with the drainage of the peat swamp lands of central Wisconsin. Here the assistance of the experts of the Department has been requested in order to determine the manner in which drainage should be accomplished and regulated during the subsequent treatment of these marshes.

The reclamation of tidal marshes is a subject upon which numerous inquiries have been received and which may be profitably studied.

The further development of the prairie lands of Arkansas and the heavy cotton lands of Mississippi will depend upon the introduction of more thorough methods of drainage. There is no public information available bearing directly on the treatment of the drainage problems there encountered, although it is a fundamental matter in the development of certain lands in these States.

The drainage experts of the Department have given considerable time and thought in advising with and aiding agricultural colleges and stations about courses of instruction in drainage engineering and the carrying out of experiments in drainage. The establishment of these courses of study and the special training of men to carry out this branch of farm improvement promise much for the betterment of soil conditions and soil production in future years. The success of these classes is shown by the fact that Illinois has 42 and Iowa 65 students at present enrolled in drainage engineering.

AGRICULTURAL ENGINEERING.

The valuable results which have come from including irrigation and drainage in the work of the Department leads me to believe that this investigation should include two other branches of agricultural engineering with which they have a close relation. These are farm buildings and farm machinery.

That this Department should give some attention to the convenience and healthfulness of farmhouses and farm buildings would not seem to

require any argument. These have such vital relation to the attractiveness and profits of farming and to the improvement of the social and industrial conditions of farm life that they ought not to be ignored by this Department.

There is urgent need of study of the important question of ventilation and lighting in farm barns. A recent investigation carried on by the Agricultural College of Wisconsin has shown that scores of costly barns, intended to house valuable blooded live stock, and on which thousands of dollars have been expended to secure perfect sanitary conditions, are a complete failure so far as ventilation is concerned; and that this lack of proper ventilation is causing serious increase in the spread of tuberculosis and seriously impairs the profits of feeding. Hundreds of farmers are delaying the building of barns because, while they realize the nature of the difficulty and the necessity for its remedy, they do not know how to accomplish it. It is a striking but admitted fact that we are so ignorant of the proper principles of barn ventilation that many of the costliest structures built in recent years have been the most defective in this regard.

There is another reason for this Department giving some attention to the subject of farm buildings. We are entering a transition period in which the cheap wood construction of former years is giving way to permanent structures of stone, concrete, and iron. Farm houses, through better water supplies, plumbing, and sanitation, are being made as convenient as those of the city. The working out of these changes involves so many new problems that the Department is being called upon by experiment stations, improvement associations, and communities for advice and information which if furnished could not but result in a marked improvement in the conditions of farm life.

MACHINERY AND MOTIVE POWER.

Closely related to the healthfulness, convenience, and cheapness of farm buildings is the right selection, care, and use of farm machinery. The studies of pumping machinery have shown that the most important factor in its successful use is the mechanical skill of the farmer, and we are beginning to understand that the increased complexity and cost of farm machinery make the education of the American farmer along these lines more and more desirable.

No more significant change is taking place in American agriculture than the extent to which different kinds of motive power are taking the place of men and animals. The use of the traction engine and automobile in the place of the horse on the country roads, the employment of gasoline, steam, wind, and electric power to operate mowers, threshers, plows, feed cutters, corn huskers, and dairy machinery are illustrations of epoch-making changes that are now going on on every modern American farm. On one ranch in California there is $60,000

worth of farm machinery operated by some other power than animals or man. For want of proper information these changes are involving farmers in serious mistakes and large losses. They buy motors not suited to their requirements or which they do not know how to operate. They buy machinery not adapted to their condition and cause its rapid destruction by not knowing how to care for it.

There is made and sold each year in this country about $100,000,000 worth of farm machinery. Fully one-half of this goes into the hands of men who do not know how to select it wisely or to keep it in proper condition. The waste which results runs into millions of dollars annually. In addition, implement manufacturers lose large sums in making and attempting to introduce machinery unsuited to the work it is intended to perform, with a resultant loss to both farmers and manufacturers.

Realizing the need of improvement in these matters, and partly to meet the requests of implement manufacturers for young men having agricultural and mechanical training which will enable them to design and construct implements suited to the conditions of the American farm, a number of agricultural colleges and experiment stations have inaugurated courses of instruction and begun systematic experimentation for the purpose of bringing about a general diffusion of intelligence about this feature of farm work. They have appealed to this Department for aid in this work similar to that already given them in other lines of agricultural investigation.

TESTS OF CORN PLANTERS AND WINDMILLS.

As illustrating the important results which are destined to come from the inauguration of this work, one of the results of an investigation carried out by the Iowa State College, a pioneer in this line of education and experimentation, will be given. It began its study of farm machinery with the operation of corn planters, because no single factor contributes more to the yield than securing a uniform stand, and this is impossible if the seed is not planted evenly. The machines for planting corn in hills are intended to drop from three to four grains, yet farmers have been buying, and implement makers manufacturing and selling, planters without any definite knowledge as to how they behave in this respect. In making this test all of the leading machines were included. It brought out the following significant facts:

(1) That no planter now made will drop evenly unless the grains have been graded. The introduction of seed-grain graders followed, and was an immediate, important, practical gain to agriculture and to manufacturers of this kind of machinery.

(2) That with graded grain certain types of machines do accurate work.

(3) That other types will not drop evenly under any conditions.

The important and encouraging feature of this investigation has been the interest shown by manufacturers who have accepted the results as impartial and conclusive. Makers of machines found defective were as ready to accept the results as the makers of those which operated properly, the defects being at once corrected.

The test of windmills by the Iowa State College to determine the designs and sizes best suited to lifting water for irrigation promises to lead to important results in extending the use of this motive power in grinding grain, handling and storing produce, and doing some other kinds of farm work practically without expense, which formerly required a considerable expenditure for man or animal power.

NEED OF AN EXPERT IN FARM BUILDINGS AND MACHINERY.

The requests of the colleges and stations for aid in carrying out these investigations and in planning courses of instruction have been supplemented by numerous similar requests from farmers for advice and assistance about the selection and operation of different kinds of farm motors and other farm machinery. In the absence of any special arrangement for dealing with these problems, they have been referred to the Office of Experiment Stations and dealt with by the Irrigation and Drainage division of that Office; but there are at present no funds which can be utilized for systematic work along these lines. I am of the opinion that results of great value, alike to the farmers and the manufacturers of agricultural machinery, will come from the extension of the Department's work in agricultural engineering to include studies of this character, in cooperation with the agricultural colleges and experiment stations. I have, therefore, asked Congress for an appropriation which will enable us to employ an expert in farm buildings and farm machinery, in connection with the irrigation and drainage investigations.

DIVISION OF PUBLICATIONS.

The publication work of the Department is a faithful reflex of its activity and growth. The diffusion of the valuable information acquired by the Department is effected almost entirely through this medium. The time was, indeed, when in spite of the comparatively few publications issued, the cost of printing them amounted to far more than half the entire expenses of the Department. At present the entire cost of this work is not even one-sixth of the total expenditures of the Department, and yet the number of publications issued during the past fiscal year aggregated 972. Of these, 379 were new, comprising about 23,000 pages of matter. The number of copies of all publications issued during the year aggregated 12,421,386. The

600 reprints attest forcibly the extent of the demand for the Department publications.

Of the whole number printed 415 were Farmers' Bulletins, of which 25 were new and 390 reprints. The total number of copies of these issued during the year was about 6½ million, very nearly 5 million being distributed upon the orders of Senators, Representatives, and Delegates in Congress.

A very gratifying feature reported by the Department Editor is the constantly increasing demand for the Department publications by educational institutions, mainly for class work. This has added, however, very much to the demands made upon us, and, unfortunately, has greatly increased the instances where it has been found impossible to comply with applicants' requests owing to the exhaustion of the supply.

This suggests the possibility, with the cooperation of Congress, of utilizing, after sufficient time has elapsed, a portion of the unused Congressional quotas of many of our documents. If some plan could be devised, with the approval of Congress, whereby such unused quotas could be made available to the Department, a great deal of valuable matter would go into circulation which at present is not used in any way.

It is gratifying to be able to report that Congress at its last session adopted a resolution authorizing the Superintendent of Documents to utilize the funds received by him from the sale of public documents to reprint such as are in continuous demand, subject to the approval of the head of the Department from which the document to be reprinted had emanated. This official courteously supplies the information that out of a total of 47,800 Government documents disposed of by him during the fiscal year, for which he received the sum of $12,606.17, 31,860 were publications of this Department, and the amount received therefor was $4,309.60. This again testifies in a marked manner to the increasing appreciation of the work of the Department, especially in view of the very large gratuitous distribution, not only directly through the Department, but also through members of Congress.

Every effort has been made to reduce the cost of printing. The editions have been restricted to actual and urgent requirements, and every means to reduce expenses, short of interfering with efficient service, has been resorted to. In the matter of illustrations especially, originally a very natural source of extravagance, rigid restrictions have been imposed. As a result, notwithstanding the considerable increase in the number of publications and in the total number of pages of new matter, the number of illustrations in the new publications issued during the year has been reduced by over 500, or more than 20 per cent of the previous year.

THE LIBRARY.

The Department's collection of agricultural and technical scientific literature has been enriched the past year by the addition, by purchase and gifts, of more than 4,000 volumes. As a working library for the practical agriculturist and scientific investigator this collection of books now stands unsurpassed by any single collection. Some of the special collections of technical scientific works rank among the first in the country. More than ever before have the resources of the Library been made available to scientists in various parts of the country. Loans of this nature, which do not interfere with the progress of work in the Department, are greatly appreciated by experiment station workers in particular. Among the many valuable additions to the Library the past year have been a number of rare entomological works, which have long been needed to make the collection of books on this special subject more nearly complete. A printed catalogue of the books on entomology in the Library will be issued in a few months, thus adding another contribution to the printed subject-catalogue of the Library.

In return for the large number of Department publications transmitted to foreign countries through the Library, the number of exchanges from governments, institutions, and societies has greatly increased. These publications cover largely the results of current scientific work abroad and are of signal importance in the work of the Department.

The cataloguing of current accessions has practically been kept up to date. Printed index cards for the Department publications have been issued in larger numbers than before to meet the increasing demand from libraries in all parts of the country which receive the publications indexed. In addition to these cards similar cards have been prepared for three important agricultural periodicals, the printing, distribution, and sale of the latter cards having been carried on in cooperation with the Library of Congress. The quarterly Library bulletin of accessions has been regularly issued.

The number of volumes bound the past year has exceeded that of any previous year, yet the desired number of 3,000 volumes a year, until there are no unbound volumes on the shelves, has not been reached from lack of sufficient funds to provide for this work.

With the growth of the Department the work of the Library has increased proportionately, both in the direction of the purchase of books and periodicals and in respect to reference work in connection with current investigations. Each year its steadily increasing resources make the Library a working collection more and more depended upon for necessary data in the furtherance of Department work in its numerous branches.

ACCOUNTS AND DISBURSEMENTS.

The total amount appropriated by Congress for the expenses of the Department for the fiscal year ended June 30, 1904, was $5,258,160, an increase of $244,200 over the appropriations for the preceding year. Of this amount about four and one-half millions had been expended at the close of the year, and the unsettled accounts were nearly sufficient to consume the unexpended balance of $768,839.43. The appropriations for the current year aggregate $5,942,040, an increase of $683,880 over those for the year ended June 30, 1904.

There was received from various sources and deposited in the Treasury the sum of $11,322.58. Among the larger items of these receipts were $4,392.46, resulting from sales of condemned property, $2,960.69 from sales of American products in Europe, and $2,337.33 for telegraph service by the Weather Bureau.

The amount appropriated for rental of buildings for the use of the Department in the District of Columbia for the current fiscal year is $39,820, an increase of $11,920 over the appropriation for the past year.

During the year buildings for the Weather Bureau have been completed at seven different points at a total cost for sites and construction of $70,900. Buildings are in course of construction at four points, the total cost of which will approximate $43,642. The total value of buildings and sites now owned by the Weather Bureau in the District of Columbia and at other points is $382,662.67. The erection of buildings for the use of the Weather Bureau saves a large annual expense for rentals.

PERSONNEL OF THE DEPARTMENT FORCE.

The annual report of the Appointment Clerk shows that the total number of persons constituting the body of the Department of Agriculture on July 1, 1904, was 4,504, an increase of 2,160 since July 1, 1897. In addition, there are nearly a quarter of a million special correspondents and reporters who, although receiving no financial remuneration from the Department, cooperate with it and render it much valuable service. These deserve the utmost credit for the public spirit which animates them.

PROGRESS ON NEW DEPARTMENT BUILDINGS.

The work connected with the new buildings for the Department of Agriculture, authority for which was announced in my last report, has progressed satisfactorily during the year. As already announced, Congress has authorized an expenditure of $1,500,000 for these buildings. For the greater part of the past year the architects have been

engaged, under the direction of a committee consisting of three bureau chiefs in the Department, in preparing the detailed plans and specifications for the buildings. The plans were completed in full August 25, 1904, and steps were at once taken for the securing of proposals. In asking for proposals it was planned to have the matter considered under two general propositions: (1) The buildings to be erected entirely of granite, and (2) the buildings to be erected with granite base and marble superstructure. Twenty bids for the entire work were received, opened, and scheduled on November 10. The bids on the complete structure ranged from $1,153,000 to $1,612,000. After careful consideration by the building committee and the architects, it has been decided to erect the buildings with granite base and marble superstructure. The two lowest bids for this work were submitted by Mr. Ambrose B. Stannard, of New York—one for $1,206,000, the other for $1,199,000, the difference of $7,000 in price being caused by the difference in style of granite used for the base. The committee has unanimously recommended that Mr. Stannard's bid for $1,206,000 be accepted, and this has been done. It is gratifying to announce, therefore, that the actual work on construction will begin within the next few days.

THE LATE COL. J. H. BRIGHAM.

In concluding my report, it becomes my sad duty to record the death of Col. Joseph Henry Brigham, Assistant Secretary of Agriculture, which occurred suddenly at Delta, Ohio, on June 29, 1904.

Colonel Brigham enlisted in 1861 and served throughout the war with great credit, being mustered out with the rank of colonel. From the date of his enlistment, Colonel Brigham may be said to have devoted his life to the service of the public, and especially to the cause of agriculture. He was for six years a member of the Ohio State board of agriculture, and served one year as its president. He had also served in the Ohio State senate, and had been appointed by the late President McKinley, then governor of Ohio, president of the State board of managers of the penitentiary of that State. Prior to his appointment by President McKinley to be Assistant Secretary of Agriculture, however, he was perhaps best known as master of the National Grange, a position which he held for nine years.

While he was serving as Assistant Secretary I had the honor to recommend him for appointment on the Government board of managers of the Pan-American Exposition as the representative of the Department of Agriculture, and he was subsequently appointed chairman of the board by President McKinley. By your appointment he held the same position on the Government board of managers of the

Louisiana Purchase and the Lewis and Clark expositions, and he was filling these positions when he died.

Colonel Brigham was frequently designated to represent the Department at important gatherings throughout the country, and on all such occasions he not only succeeded in interesting and impressing his audience, but by his unassuming deportment, genial yet dignified, he added greatly to his own and the Department's popularity. At his funeral at Delta, Ohio, on the 3d day of July last, which served to demonstrate in a marked manner the high esteem in which he was held by his fellow-citizens, his friends and neighbors, the Department was represented by a committee of its officers appointed by me for this purpose.

Born and bred a farmer, Colonel Brigham was a notable example of a man who attained eminence without ever abandoning the occupation of his youth. His experience and judgment, his public spirit and fidelity to duty, made him valuable in every position which he filled, and it is with a deep sense of personal and public loss that I pen this record of his death.

In the foregoing report I have endeavored to show the relation of the farmers to their coworkers throughout the country, and also the leading position which agriculture occupies among our industries. I have endeavored to give an outline of some of the directions in which the Department seeks to help the farmers of the United States. Its existence is justified only by the extent to which it serves the tiller of the soil through research and the practical application of science.

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 26, 1904.*

DEPARTMENTAL REPORTS.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

U. S. Department of Agriculture,
Weather Bureau,
Washington, D. C., October 4, 1904.

Sir: I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year that ended June 30, 1904.

Respectfully,

Willis L. Moore,
Chief of Weather Bureau.

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

PRACTICAL VALUE OF FORECASTS AND WARNINGS.

Weather forecasts for thirty-six and forty-eight hours in advance have been made daily throughout the year for each State and Territory, and special warnings of gales on the seacoasts, Gulf, and Great Lakes, and of cold waves, frost, heavy snows, floods, etc., have been issued when the advices were calculated to benefit commercial, agricultural, and business interests. The North Atlantic and West Indian storm-warning service was continued, and forecasts for the first three days out of steamers bound for European ports were issued daily at 8 a. m. and 8 p. m. In a number of instances European shipping interests were notified of the character and probable course of severe storms that were passing eastward from the American coast.

A WEST INDIAN HURRICANE.

The first important tropical storm of the year moved from the Windward Islands of the West Indies over the Caribbean Sea and the Gulf of Mexico from August 8 to 15, 1903. The vortex of this storm passed over or near the island of Martinique during the night of the 8th–9th, reached Jamaica on the morning of the 11th, crossed the Cayman Islands during the evening of the 11th, advanced over northern Yucatan on the 13th, and apparently dissipated on the Mexican coast of Tamaulipas during the 15th. Except during its passage over Jamaica the center of this hurricane did not come within the region of observation. Beginning with the first indications of its appearance near the Windward Islands, however, shipping interests and West Indian sta-

tions were advised daily regarding its character and probable course. At Kingston, Jamaica, the barometer fell to a minimum of 28.80 inches, and on the island the losses to owners of banana plantations were estimated at more than 500,000 pounds sterling, and the destruction to houses, property, and plantations was appalling. At Grand Cayman Island a minimum barometer reading of 28.30 inches was recorded in the harbor of Georgetown, and of 23 vessels in the harbor but one was saved. Every tree or plant on the island was either blown away or had its leaves and small branches stripped off, crops were entirely destroyed, and about 200 houses were blown down or unroofed. Reports from vessels that encountered the storm in the Gulf of Mexico show that it diminished rapidly in intensity after passing westward from the Caribbean Sea.

VESSELS SAVED FROM A BAHAMA STORM.

In September, 1903, two storms of marked intensity advanced from the subtropical region north of the West Indies to the Atlantic coast of the United States. The first of these storms appeared over the Bahamas on the morning of the 10th, advanced north of west over the southern point of Florida by the morning of the 12th, moved northwestward over the eastern part of the Gulf of Mexico during the 12th and 13th, after which it diminished in intensity and finally dissipated over the South Atlantic States. At Nassau, New Providence Island, Bahamas, the wind reached an estimated velocity of 90 miles an hour, and at Cat Bay, Bahamas, a minimum barometer reading of 28.30 inches was reported. During its progress over Florida and the Gulf, the storm destroyed property to the value of $100,000 from West Palm Beach to Miami, Fla., and 9 lives were lost by the stranding and breaking up of the British steamer *Inchulva* at Delray. The steamer and cargo were valued at $350,000. Other marine losses amounting to about $20,000 were reported on the eastern Florida coast. At Tampa, Fla., the barometer fell to 29.42 inches, the wind blew in squalls at a rate of 50 to 60 miles an hour, buildings were destroyed or damaged to the extent of about $200,000, and great havoc was wrought in the orange groves of the surrounding country.

The warnings and advices issued in connection with this storm permitted all possible precautions to save exposed property, and comparatively little damage was caused to vessels.

Mr. C. E. Garner, president of the Jacksonville Board of Trade, has written as follows regarding the warnings:

> I wish to express my appreciation of the timely warnings given by the Weather Bureau both at this point and at Tampa during the recent West Indian hurricane. They were especially valuable at Tampa, as I have steamers operating from that point to Manatee River and Terra Cela Bay points, and the notice we had from the Weather Bureau prevented our leaving port on Saturday, the 12th. The observer at Tampa kept us fully advised as to the situation there, and his warnings to vessels not to leave port, in my judgment, prevented serious disasters. I think it is very fortunate for the agricultural and shipping interests of this State that we have such an efficient service of the Weather Bureau, and that the service is in the hands of such capable and accommodating officials.

The Tampa Evening Herald of September 15 comments editorially regarding the storm, and says, in part:

> Too much credit for the saving effected can not be given to the Weather Bureau, and it is the intention of this article to direct public attention seriously toward one of the most valuable of the Government branches in this city.

The Weather Bureau observer at Jacksonville, Fla., reports that there is no doubt that a large amount of property and a number of lives were saved by the timely display of the storm warnings. During the displays ten vessels, the approximate value of which was one-quarter of a million dollars, remained in port at Jacksonville, and three vessels, valued at $135,000, at Fernandina. Sponge and fishing vessels, valued at nearly $200,000, and employing hundreds of men, remained in ports along the Florida coast, and the display of warnings undoubtedly saved many of these vessels and their crews. The observers at Tampa and Pensacola gave the widest possible distribution of the warnings, and state that they were, as usual, well heeded.

On September 16 a severe storm of small area advanced from the Atlantic Ocean and moved northward along the middle Atlantic coast, causing the loss of a number of lives and some destruction of crops and seaside property. Owing to the unusual character and course of this storm its indications did not result in a display of warnings until the morning of the 16th.

WARNING OF PACIFIC COAST GALES.

The severest storm of the year on the Pacific coast occurred on the night of March 9–10, 1904, when barometric pressure was below 29 inches on the Washington and Oregon coasts. The gales that attended this storm were severe from British Columbia to San Diego, Cal., and heavy rain fell in the coast districts and heavy snow in the mountain regions of the North Pacific States.

The Humboldt Standard, Eureka, Cal., of March 10, 1904, remarks as follows regarding the work of the Weather Bureau in connection with this storm:

One of the most violent storms that ever occurred on the coast of northern California was heralded yesterday morning by the display of southeast storm warnings at the local Weather Bureau station. The warnings were ordered up by District Forecaster McAdie twelve hours before the storm struck this city. All of the shipping in the bay having ample notice from the Weather Bureau there was no damage to vessels, all shipping being securely tied up, with no vessels at anchor.

SPECIAL FORECASTS OF SNOW.

The following are some of the special snow warnings that, in addition to the regular forecasts, were issued for the benefit of transportation interests:

January 2, 1904: Snow will be heavy in the interior of New York and New England this afternoon and to-night, with high northeast shifting to northerly winds.

January 26, 1904: Heavy snow indicated for the interior of New York and New England during next twenty-four hours, with high southerly shifting in New York to much colder northwest winds to-night.

April 15, 1904: Heavy snow and high easterly shifting to northerly winds indicated for the lower Lake region to-night.

SAVINGS BY COLD-WAVE AND FROST WARNINGS.

The following comments have been made regarding cold-wave and frost warnings:

[The Daily Picayune, New Orleans, La., November 19, 1903.]

Sugar planters have been warned by the Weather Bureau to prepare for temperatures as low as 25°, and reports received seem to indicate that they are acting in

accordance with the warnings, and protecting the cane crop. A temperature of 25° so early in the season would damage the cane crop to the extent of millions of dollars unless protection is accomplished. Since sugar cane grows richer in sugar content with every day that it is allowed to grow, many planters cut their cane only as fast as they can manufacture sugar. In some seasons grinding is completed without a freeze, and the cane harvested at the close of the season gives much greater production than that harvested at the opening. With a feeling of certainty that he will be warned by the Weather Bureau of an approaching freeze in time to enable him to protect his crop, the planter lets his cane grow until warned by the United States Weather Service to protect his crop. The Weather Bureau has in the past saved millions of dollars to the sugar planter, for there has not been a freeze in recent years but what the lowest temperature which occurred has been announced in warnings issued twenty-four to thirty-six hours in advance of its occurrence.

[The Savannah News of January 7.]

When the first intimation of the cold wave's approach was received at the Weather Bureau word was at once sent to florists and they were warned to have their fires up. These were immediately started, and when the wave reached here flowers were well protected.

[The San Francisco Call of January 20, 1904.]

Reports to-night from correspondents stationed throughout the orange districts of southern California are to the effect that the frost this morning did little damage to the citrus crop, which is now practically ready for market. Having received special warnings from the Weather Bureau, hundreds of ranchers resorted to smudging this morning and thereby removed all danger to their crops.

[The San Francisco Chronicle of March 20, 1904

The farmer shares equally with the merchant the advantages of Weather Bureau warnings, and every year this service increases in efficiency and value. Many millions of dollars have already been saved by the fruit growers of California by timely warnings sent out, enabling citrus growers to protect their crops against frost, and the raisin, prune, and apricot growers to stack their trays of drying fruit before overtaken by rain.

[The Daily States, New Orleans, La., March 4 1904.]

The warnings of the United States Weather Bureau were, as usual, timely and accurate, and they enabled the protection of berry crops and truck gardens, and have thus saved thousands of dollars to the farming interests.

[The Advertiser, Montgomery, Ala., March 5, 1904.]

The Weather Bureau's warning saved many thousand young cabbages and tomatoes which were exposed in cold frames, almost ready to transplant, and which would have been killed had warnings not been received. This item of benefit from the Bureau's warnings means $50,000 or more to the truckers of this section. Had these young plants been killed, an entire new crop of early sets would have had to be started, which would make the vegetables too late to command lucrative prices in the Northern markets. The warning, verified to the degree, was far enough in advance to be of great benefit.

RIVER AND FLOOD SERVICE.

PROGRESS IN WORK AGAINST ICE PACKS AND FLOODS.

Happily the floods of the year did not nearly approach in character and importance the great overflows of the spring of the year immedi-

ately preceding, with their destruction of over 100 human lives and property valued approximately at over $40,000,000. There were, nevertheless, severe floods at various times, and in the management of the work occasioned by them the river and flood service continued to demonstrate its usefulness and growing efficiency as a valuable branch of the Weather Bureau. That there has been a constant increase in the accuracy of its work is evidenced by the more specific and detailed character of the forecasts and warnings in localities where such refined work had heretofore been considered practically impossible. The service performed during the prevalence of the great winter ice gorges in the Susquehanna, Allegheny, and Ohio rivers, with their attendant floods, was especially noteworthy. These gorges were the greatest in the history of the localities, and that their great dangers were minimized is due in no small degree to the timely advices and warnings of the Weather Bureau.

There were minor floods during nearly every month of the year, but each was amply covered by timely warnings. These floods were not in any sense alarming or dangerous, but they nevertheless attained sufficient importance to endanger a large amount of property, which without the benefit of the Weather Bureau advices and warnings would have been totally lost. As a matter of fact, considerable damage was done by these small floods, principally to growing crops which, of course, could not be protected, but the value of property saved by removal and otherwise was not far from $1,000,000.

ICE GORGES IN PENNSYLVANIA.

The great floods of the year were caused by the enormous ice gorges that formed in December in the Ohio and Susquehanna rivers, and continued during January in the Ohio and until late in March in the Susquehanna. The latter gorge was easily the greatest in our recorded history, the nearest approach to similar conditions having occurred in the same locality twenty-nine years before. From a short distance below Wilkesbarre, Pa., almost to the mouth of the river, a distance of 180 miles, there was practically a solid wall of ice, filling the river from bank to bank, and extending into the West Branch and Juniata rivers far up to their sources in the Alleghenies. In the North Branch of the Susquehanna, from Beach Haven to Sunbury, there was an unbroken mass of ice 40 miles in length and from 15 to 25 feet in height, much of it resting upon an entirely dry river bed. The floods caused by the gorges were very destructive. Towns, villages, farms, and railroad tracks were covered with masses of ice many feet in thickness, and bridges—some of them enormous steel structures—were moved from their piers. Below Harrisburg the destruction was even greater, although, owing to the wider channel, the ice was not piled so thick. Flood waters, carrying enormous masses of ice, were responsible for the major portion of the damage. At Middletown, Pa., the water reached a stage of 34.5 feet, the highest on record, and 5 feet higher than that of June 2, 1889, memorable as the period of the great Johnstown disaster. Some idea of the immensity of the gorges may be afforded by the statement that as late as May 20, 1904, ice in considerable quantities was seen in the Susquehanna River between Harrisburg and York Haven, Pa.

WARNINGS ON THE OHIO RIVER.

The Ohio River situation was equally unparalleled and almost equally grave, but very fortunately it was relieved without serious incident after a series of trying experiences and a prolonged period of apprehension. At Pittsburg the water reached a stage of 30 feet—8 feet above the danger line—and the official in charge of that station, with his corps of assistants, was compelled to remain on duty for forty-eight consecutive hours to receive reports from substations, issue warnings and advices, and furnish information to the public. Over 2,000 telephone calls were received and answered during that time. The Cincinnati situation was another that required the exercise of the best judgment as well as unremitting attention, the critical time coming when the ice gorges began to move. Elaborate preparations had been made for this event and its passage found no one unprepared.

It can readily be seen that these situations were such as to require the exercise of the best possible judgment, combined with the utmost vigilance and caution. The officials in charge of the districts were constantly on duty, day and night, during the critical periods. Every effort was made to keep the people over the districts thoroughly alive to the extreme danger and gravity of the situation, and to the success of these efforts may be attributed the extremely gratifying fact that there is no record of the loss of even a single human life during a period of such imminent danger. The property loss was very heavy, but there were no losses that could have been averted. The people had been thoroughly prepared and every possible precaution was taken.

LOWER MISSISSIPPI PROBLEMS.

The lower Mississippi flood of the spring of 1904 was not remarkable. The usual warnings were issued one to two weeks in advance, and there were no abnormally high stages of water except at Memphis, where a stage of 39 feet was recorded, but 1.1 feet below the great high-water mark of the previous year. Some damage and inconvenience resulted, but the flood caused no great losses, and in a technical sense it afforded some extremely valuable contributions to our knowledge of the local régime of the Mississippi River.

The much-debated question as to the influence of the railroad embankment on Hopefield Point, opposite Memphis, in the apparent ponding of the waters of the Mississippi, has evidently been decided. The experiences of the last flood and that of the preceding year would seem to indicate that this water was not ponded, but that it was overflow water that had come through Reelfoot Lake district and was reentering the river.

It is also worthy of note that for the first time the St. Francis levee successfully withstood a severe flood.

EXTENSIONS OF THE RIVER AND FLOOD SERVICE.

Some extensions of the river and flood service have been made during the year. The Texas service was the first to be improved, the new service having begun promptly on July 1, 1903, with the addition of eleven reporting stations on the Sabine, Neches, Trinity, and Colorado

rivers. Four days later the first flood warning was issued for the Trinity River. The North Pacific district has also been much improved, and the service will doubtless prove much more satisfactory in the future. Some lesser extensions have also been made, and the field of operations has been broadened during the year as much as the limited appropriations available would permit; but much yet remains to be done in order that the service may be made commensurate with the demands upon it. Very fortunately Congress, with a realization of the importance of the work, has appropriated a substantial increase for the river and flood service, and in a short time a considerable number of new stations will be in operation.

Arrangements have already been completed for the inauguration of a new service over the Kansas River watershed, the scene of the memorable floods of May, 1903.

LONG-RANGE FORECASTS.

It is hoped the time will come when it will be possible to forecast the weather for coming seasons—to specify in what respect the coming month or season will conform to or depart from the weather that is common to the month or season—but that time has not yet arrived, and the officials of the Weather Bureau have been informed that they will best serve the public interests when they teach the communities they serve the limitations of weather forecasting and warn them against imposition.

It is the opinion of the leading meteorologists of the world that the public interests are injured by the publication of so-called long-range weather forecasts, especially by such predictions as relate to severe storms, floods, droughts, and other atmospheric phenomena of a dangerous or damaging character. The publication of monthly forecasts has reached such proportions that it is deemed advisable to inform the public as to their harmful character. Some long-range forecasters may be honest, and may, in their ignorance, attach undue importance to storms that accidentally coincide in time of occurrence with certain relative positions of the planets, or with changes in the phases and positions of the moon, or with periods of increase or decrease in sun spots or apparent variations in solar intensity. They may believe that they have discovered a physical law or a meteorological principle that has not been revealed to astronomers, meteorologists, or any other class of scientific investigators; but the publication of predictions that, by reason of their inaccuracy, are injurious to agricultural, commercial, and other industrial interests, casts a serious doubt upon the honesty of their makers. Such publications bring the science of meteorology into disrepute, and can not, therefore, be made in response to a desire to advance that science along useful lines; and they retard the work of the honest investigator through whose efforts only can such gains be made in the fundamental knowledge of the causation of weather as will justify the making of forecasts for a month or season in advance.

VERIFICATION OF LONG-RANGE FORECASTS.

As the result of personal verification of the work of long-range weather forecasters, some of whom have so far gained the confidence of

the rural press as to receive liberal compensation for their predictions, I am led to the conclusion that these forecasters do positive injury to the public at large.

Professors Garriott and Henry have personally verified much of the work of several of the most popular long-range forecasters, and much of what follows on this subject is extracted from a report recently rendered by Professor Garriott.

The proof of a forecast is in its verification. Measured by this standard, long-range weather forecasts have an experimental value only, a value that does not justify their employment in the actual work of forecasting for specified dates and places.

Meteorologists who have conceived theories for long-range forecasting, or who have tested theories advanced by others, have applied to the theories the test of facts that are presented by meteorological records, and the results have been negative. Men who issue fake forecasts have adopted an opposite method—they have carefully ignored and concealed facts, and have depended upon advertisements of occasional successes that will inevitably occur in any system of chance.

The success of a long-range weather forecaster is usually measured by the extent to which he can impose upon the credulous and the ignorant. As a rule it is impossible to subject the rambling and indefinite statements of the long-range weather forecasters to a verification. In the summer of 1903, however, one of these forecasters was induced to submit to the Weather Bureau some forecasts for verification. The forecasts consisted of an enumeration of certain dates around which "storms would cluster and develop great intensity." The periods, or dates, of maximum storm force, as given by the forecaster, appear in italics at the beginning of the six paragraphs next following, and a statement of the actual weather that occurred follows each date.

August 11, 1903: On this date there were no storms in any part of the United States and no extraordinary weather conditions were manifested at any point within the region of observation, except that a tropical disturbance of small diameter was apparently moving westward south of Jamaica, West Indies. As the forecast did not specify in what part of the Northern Hemisphere the storms would reach their maximum intensity, it can not be considered that the occurrence of this storm in any way verified the forecast.

August 24, 1903: On this date no evidence could be discovered of an increase in storm force, the usual stagnant summer conditions prevailing in all parts of the United States.

September 7, 1903: On this date the weather conditions were not unusual; there were no storms of marked energy in any part of the country. A disturbance covered the northern Rocky Mountain region and the upper Missouri Valley, but it moved northeastward and did not in any way affect the region to the eastward. There was nothing unusual in the disturbance above mentioned. A storm of considerable energy developed, however, in the vicinity of the Bahamas on September 10 and persisted in the vicinity of the Gulf region until the 15th. No mention was made of this disturbance in the forecast.

September 21, 1903: On this date likewise the usual weather conditions prevailed in all parts of the region of observation.

October 6, 1903: On this date a depression of considerable magnitude covered the eastern slope of the Rocky Mountains. It moved eastward

and developed into a severe storm on the Atlantic coast on the 9th and 10th, three days after the date set by the forecaster.

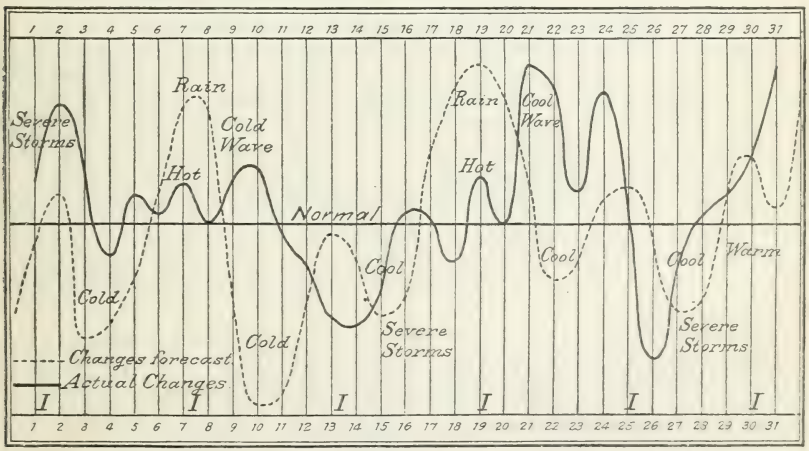
October 19, 1903: On this date the usual October weather prevailed in all parts of the United States. There was not the slightest evidence of increased storm energy on this date.

This is a plain statement of the weather conditions experienced on the dates when, according to the forecasts, the most severe storms of recent years were to occur. Let us quote one of the forecasts:

> Clustering around September 7 and 21, October 5 and 20, will come some of the most severe storms of recent years. These will be so general all around the earth that I advise all to be on guard near the dates named. Storms miss 99 out of 100 places, but you will at least read of tornadoes, hurricanes, cloud-bursts, electrical storms, and seismic disturbances in nearly all sections where these sometimes occur.

Considerable time has already been devoted to an examination of forecasts of this character, and the results thus far show that the forecasters possess no knowledge that would justify them in the making of predictions.

The character of the work put forth by long-range forecasters is illustrated in the diagram below, which was made by one of those claiming the largest share of public attention. The central line is supposed to represent the normal temperature for March, 1904, and the dotted line indicates the changes forecast for that month. When the dotted line passes above the normal line warmer weather is indicated, and when it falls below the normal line colder weather is indicated. The original diagram from which the illustration reproduced below was taken does not show the amount of the expected temperature changes. In other words, it is conveniently left to the reader to determine the intensity of the hot wave or the cold wave scheduled for any given date. It is true that the crests of the warm waves and the cold waves are placed at different distances from the normal line, but the vital point, viz, the value of distance above and below the normal line, has been omitted.


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Severe Storms
Rain
Cold Wave
Hot
Normal
Cold
Cool
Severe Storms
Rain
Cool Wave
Hot
Cool
Cool
Warm
Severe Storms
Cold
Changes forecast
Actual Changes
I I I I I I
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

MARCH, 1904, WEATHER CHART: The solid black wavy line, the word "normal," and the explanation in the lower left-hand corner were put upon the above chart by the Weather Bureau. All other matter, including the words "severe storms," "cold," "rain" "cold wave," "hot," "cool," etc., were copied from the original chart issued by this particular long-range forecaster. The dotted wavy line represents the temperatures predicted by him; the solid black wavy line the actual temperatures as recorded at St. Louis, Mo., a city on the ninetieth meridian.

The long-range forecaster says:

"In the above chart the letter I indicates the dates about which storm waves, "moving eastward, will reach meridian 90, which is about the same as the general "course of the Mississippi River. All weather events move eastward across the "continent and those marked on the chart are expected to reach meridian 90 about "the dates indicated. The straight, trebble,[a] horizontal line, running through middle "of chart, is the average temperature of March for many years past and the wave line "is temperature forecast for March 1904, showing where temperature is expected to "go above or below normal, indicating how warm or how cold it will be.

"*These weather charts are $1.50 a year; Weekly Bulletins $1.50 a year; 'What and "When to Plant and Sow,' $6.00 a year gives complete weather forecasts and advice; "Probable effects of weather on Chicago and New York market prices of grain and cotton "$3.00 a month.*"

I have superposed upon the original drawing a solid black line showing the actual daily departure of the temperature from the normal at St. Louis, Mo., longitude 90° 12′ west from Greenwich. The scale used in entering the temperature departures was 16 degrees to the inch, or 1 degree to each sixteenth of an inch. I have also reproduced verbatim the explanation that accompanied the so-called chart, except that I have had the closing paragraph printed in *italics*. It will be noticed that the relatively warm periods in the diagram are placed about five days apart, viz, on the 2d, 8th, 13th, 19th, 25th, and 29th, and the cold periods nearly a week apart thus, 3d, 10th, 15th, 22d, and 27th. The solid black line shows the temperature changes that actually occurred during the month.

Three "severe storm" periods are given, viz, on the 1st and 2d, 16th to 18th, and 28th to 30th. There were no severe storms during the month. The highest winds experienced were on the 10th, 42 miles, from the southwest; 22d, 42 miles, from the southwest, and 24th, 50 miles, from the west. The two last-named occurred in connection with thunderstorms and lasted but a short time. Not one of these high winds occurred on the dates assigned by the long-range forecaster.

To a long-range forecaster the occurrence of a thunderstorm or an electrical disturbance in some remote corner of the globe during one of his "storm periods" will fully justify his forecasts.

Forecasts of this character can be of no value to agricultural, commercial, or maritime interests. On the contrary, they are misleading, and, if given credence, are calculated to result in positive injury to property interests. As farmers, merchants, and mariners who keep pace with modern progress do not give credence to this class of forecasts the natural conclusion is that a long-range forecaster who receives remuneration from the press for forecasts submitted is simply catering to a class of readers who are deficient in a knowledge of the present status of popular science and who have no occasion to compare the forecasts with weather conditions that actually occur on the dates specified.

There is another long-range weather forecaster who draws his support from the American public who does not depart in any essential manner from the methods employed by the one above referred to. His statements are based upon a consideration of the moon's path with reference to the ecliptic and the equator, the phases of the moon, disturbing causes due to movements and positions of the planets—in fact a conglomerate gathering together of all imaginary and obsolete

[a] This has been reproduced as a single line. The use of three lines where but one is required appears to be simply another artifice of the long-range forecaster to avoid being specific.

notions regarding weather causes that are calculated to mystify credulous and uninformed people. He predicts the general character of a month with a consciousness that the forecast will be verified in at least some part of a great unspecified area. He then outlines "storm periods," with intervals of two to three days, which are covered by a margin that is claimed for verification purposes, and verifications are claimed if storms occur during the periods or in the intervals in any part of the United States and, at times, in the Northern Hemisphere. This system of forecasts and verifications admits of no failures. So much for his regular forecasts. Let us now examine some of his special, emphasized predictions.

In the early part of April, 1904, a tornado and severe storms were scheduled in various western papers, over the name of this forecaster, to appear "right after April 17." The storms failed to materialize in the United States during the period specified. Returns from remote parts of the Northern Hemisphere have not, however, been received, so it is possible that a justification of the forecast will be claimed. Aside from platitudes regarding average weather conditions that prevail in April, he announced that "one of the most decided, and perhaps violent, storm periods of the month extends from about the 25th to the 29th."

In the United States the period was a quiet one, and the disturbances that appeared (and one or more surely would appear within the area of the United States during the period specified) were not attended by "very general and violent storms, destructive hailstorms, and abnormal downpours of rain," which, according to the detailed forecast, should have been experienced.

His forecast statement for May, 1904, ends as follows: "The fifth storm period will be central on the 29th, and there will be violent disturbances. Watch the barometer, and if you have a trembling wife and children clinging to you for protection provide some place of safety in which to resort in case of danger."

Is it possible to soar to greater heights of nonsense? In what particular continent or country will the storm period be central on the 29th? The forecaster does not say. Is the entire population of the United States, or of the world, expected to dig cellars or caves of shelter in anticipation of a possible occurrence of a tornado whose path of destructive violence would not cover an area represented on a large map by a mark one-half inch in length made with a sharp pencil? Is it possible that a man who issues such totally unwarranted, sensational, and harmful forecasts is seriously considered by the intelligent portion of the American public? I regret to say that he and others of his kind have a considerable constituency.

CONCLUSIONS REGARDING LONG-RANGE FORECASTING.

A review of the foregoing remarks and opinions regarding the application of past and present astronomical and meteorological knowledge to the theory and practice of long-range weather forecasting leads to the following conclusions:

(1) That systems of long-range weather forecasting that depend upon planetary meteorology; moon phases, cycles, positions, or movements; stellar influences, or star divination; indications afforded by observations of animals, birds, and plants; and estimates based upon days, months, seasons, and years, have no legitimate bases.

(2) That meteorologists have made exhaustive examinations and comparisons for the purpose of associating the weather with the various phases and positions of the moon, in an earnest endeavor to make advances in the science along the line of practical forecasting, and have found that while the moon and, perhaps, the planets exert some influence upon atmospheric tides, the influence is too slight and obscure to justify a consideration of lunar and planetary effects in the actual work of weather forecasting.

(3) That the stars have no appreciable influence upon the weather.

(4) That animals, birds, and plants show by their condition the character of past weather, and by their actions the influence of present weather and the character of weather changes that may occur within a few hours.

(5) That the weather of days, months, seasons, and years affords no indication of future weather, further than showing present abnormal conditions that the future may adjust.

(6) That six and seven day weather periods are too ill-defined and irregular to be applicable to the actual work of forecasting.

(7) That advances in the period and accuracy of weather forecasts depend upon a more exact study and understanding of atmospheric pressure over great areas, and a determination of the influences, probably solar, that are responsible for normal and abnormal distributions of atmospheric pressure over the earth's surface.

(8) That meteorologists are not antagonistic to honest, well-directed efforts to solve the problem of long-range forecasting; that, on the contrary, they encourage all work in this field, and condemn only those who for notoriety or profit or through misdirected zeal and unwarranted assumptions bring the science of meteorology into disrepute.

(9) That meteorologists appreciate the importance to the world at large of advances in the period of forecasting, and are inclined to believe that the twentieth century will mark the beginning of another period in meteorological science.

OBSERVATORY BUILDINGS.

Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more cordial and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings, notably the Bradley Polytechnic Institute of Peoria, Ill., and the Epworth University of Oklahoma City, Okla. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several other universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations, among them being the Brown University of Providence, R. I., and the University of Wisconsin, at Madison, Wis.

The erection of buildings by the Weather Bureau not only saves the amount previously paid for rent of office quarters, but adds very much to the prestige of the service here and abroad. This prestige

will be further increased upon the completion of the group of observatory buildings at Mount Weather, Va., at which place it is intended to conduct extensive experimental and research work. The present appropriation provides for the erection of not less than five buildings, but this number has proven inadequate to the growing demands from all sections of the country, and it is hoped that Congress will soon increase the appropriation sufficiently to provide for the erection of not less than ten buildings annually.

Buildings owned by the Weather Bureau.

Location.	Value of lot.	Value of buildings.	Total value.
Amarillo, Tex	$1,255.00	$6,503.00	$7,758.00
Atlantic City, N. J	(a)	6,000.00	6,000.00
Bismarck, N. Dak	(a)	10,000.00	10,000.00
Block Island, R. I	1,100.00	7,700.00	8,800.00
Cape Henry, Va	(a)	9,104.25	9,104.25
Devils Lake, N. Dak	2,300.00	8,000.00	10,300.00
Duluth, Minn	2,100.00	7,900.00	10,000.00
Hatteras, N. C	125.00	4,875.00	5,000.00
Havre, Mont	1,850.00	5,700.00	7,550.00
Jupiter, Fla	(a)	6,094.95	6,094.95
Key West, Fla	2,020.00	7,994.75	10,014.75
Kittyhawk, N. C	(a)	1,616.00	1,616.00
Modena, Utah	(a)	4,346.00	4,346.00
Mount Weather, Va.:			
Observatory building	2,000.00	18,000.00	20,000.00
Power house and balloon building	650.00	8,000.00	8,650.00
Stable		2,000.00	2,000.00
Mount Washington, N. H	(b)	300.00	300.00
Narragansett Pier, R. I	4,100.00	8,000.00	12,100.00
North Head, Wash	(a)	4,000.00	4,000.00
Point Reyes Light, Cal	(a)	3,000.00	3,000.00
Port Crescent, Wash	82.00	1,000.00	1,082.00
Sand Key, Fla	(a)	5,593.00	5,593.00
Sault Ste. Marie, Mich	(a)	3,000.00	3,000.00
Southeast Farallon, Cal	(a)	5,211.22	5,211.22
Tatoosh Island, Wash	(a)	5,000.00	5,000.00
Washington, D. C	25,000.00	150,000.00	175,000.00
Yellowstone Park, Wyo	(a)	11,500.00	11,500.00
Yuma, Ariz	(a)	1,500.00	1,500.00
Total	42,582.00	311,938.17	354,520.17

a Government reservation. b Leased.

Weather Bureau buildings in course of construction, and approximate cost of each.

Location.	Cost of lot.	Cost of buildings.	Total cost.
Columbia, S. C	$3,799.00	$9,170.00	$12,969.00
Peoria, Ill	54.00	7,915.00	7,969.00
Nantucket, Mass	1,236.50	3,968.00	5,204.50
Mount Weather, Va. (3 buildings):			
Absolute building	(a)	6,500.00	6,500.00
Variation building	(a)	8,000.00	8,000.00
Kite building	(a)	3,000.00	3,000.00
Total	5,089.50	38,553.00	43,642.50

a Government reservation.

Rented buildings occupied wholly by the Weather Bureau.

Station.	Annual rent.	Other items included.
Cape May, N. J	$650.00	Heat, cleaner, light.
Durango, Colo	440.00	Heat, cleaner, water.
Flagstaff, Ariz	300.00	
Lewiston, Idaho	540.00	
Williston, N. Dak	450.00	Heat, cleaner, light, water.
Winnemucca, Nev	360.00	Heat, light, water.
Helena, Mont	504.00	Heat, water.
Santa Fe, N. Mex	360.00	
Charles City, Iowa	420.00	Heat, light, water.
Roswell, N. Mex	720.00	Heat, cleaner, light.

Stations at which observers' quarters are furnished by the Government separate from offices.

Station.	Annual rent.	
	Office.	Residence.
Havana, Cuba	(a)	$300.00
Honolulu, Hawaii	$480.00	540.00

a Public.

CLIMATE AND CROP DIVISION.

IMPROVEMENT OF ESTABLISHED LINES OF WORK.

The amount of funds allotted this division for its work during the year ending June 30, 1904, was the same as for the previous year. Therefore only those lines of work previously established have been pursued. The maintenance and improvement of established lines of work and the extension of the distribution of weather forecasts and special warnings as far as available means would permit have constituted the work of the year. The last-mentioned feature affords about the only item for especial remark in this report. Some of the older methods of distribution have in instances been abandoned for the quicker, more effective, and less expensive means of dissemination by telephone through rural telephone exchanges, the details of which are given elsewhere under the proper heading.

Action was taken during the latter part of the year to purchase a supply of thermometer supports of a new design, with a view of determining the advisability of their adoption for use at voluntary stations. These supports were not received in time to be given a test before the close of the fiscal year, but they are promised at an early date. It may be stated in this connection that there was a decided decrease in the breakage of thermometers at voluntary stations during the year, no doubt due in a great measure to a change in the method of mounting authorized in the previous year. From opinions expressed by some prominent section directors who have seen the new device, it is expected that the contemplated tests will lead to its adoption, and that a further decrease in the breakage of thermometers will result.

VOLUNTARY METEOROLOGICAL STATIONS.

Although nearly 300 voluntary stations were established during the year, the total number, 3,367, but slightly exceeds the number in operation at the close of the previous year, nearly as many stations as

were opened having been discontinued. No serious injury, however, has been sustained by the loss of a majority of the stations discontinued, as in but few instances were they located where it was important to have the records continued. Of the new stations opened a number have been located in the higher and less accessible places in the mountain districts in the semiarid States, with a view to meeting more fully the demands from irrigation engineers for rainfall data. Efforts have been continued to improve the instrumental equipment and the character of the exposure of instruments. More than 400 stations were inspected by section directors, and the inspection reports received show that, while most observers are efficient and painstaking in their work, there are but few stations that were not in some way benefited by the section director's visit.

Correspondence with the Chief Signal Officer of the Army resulted in securing the generous cooperation of that official in the opening of a number of voluntary stations in Alaska along the military telegraph lines. For this purpose twenty sets of instruments, constituting the voluntary observer's equipment, were sent to officers having charge of the telegraph lines, for the equipment of stations under charge of the Signal Corps telegraph operators. As a result of this action meteorological records are already being received from new Alaskan stations, and, with the establishment of the full number of stations for which equipments have been provided, the Bureau will receive meteorological data from a region concerning which available information is very meager.

In March, 1904, action was taken to establish a section of the Climate and Crop Service of the Bureau in the Hawaiian Islands. Twenty complete instrumental outfits were sent to Honolulu for this purpose and other arrangements, incident to the inauguration of a section of the Climate and Crop Service, had so far advanced by the close of the year as to justify the hope that the section would be in full operation and issuing the standard publications before the close of the succeeding year.

CLIMATE AND CROP BULLETINS.

No change has been made in the character of the National Climate and Crop Bulletin, nor in the method of collecting the reports used therein. This bulletin continues to be one of the most important publications of the Bureau, supplying, as it does, very complete information as to current weather conditions and their effects upon farm work and the growth and development of crops. The scope and purpose of this publication have been fully stated in previous reports.

MONTHLY REPORTS AND ANNUAL SUMMARIES OF CLIMATE AND CROP SECTIONS.

Each of the forty-three section centers has without interruption issued monthly reports and annual summaries containing the data afforded by the reports of the regular and voluntary stations. The demand for these publications is constantly increasing, rendering it necessary to secure the strictest economy in their distribution. They answer so fully and in such detail so many requests for information as to the climate of the different sections of the country that an application for information of this character can nearly always be satisfactorily met by supplying a monthly report or an annual summary.

SNOW AND ICE BULLETIN.

This publication, issued from the first week in December to the last week in March, shows the depth of snow on ground and the thickness of ice in rivers and other bodies of water. It meets an important need in supplying information as to protection afforded by snow to the winter wheat crop during the trying periods when the crop is exposed to injury from alternate thawing and freezing of the ground. It also continues to be of value to ice dealers and the manufacturers of rubber and other goods, the sale of which is largely governed by the presence or absence of snow or ice.

CORN, WHEAT, COTTON, SUGAR, RICE, AND FRUIT SERVICES.

These services have continued without change in the method of collection or publication of reports. Daily bulletins are issued from the several district centers, containing the full report from each substation, with the averages for all stations in each of the various districts.

SECTION SNOW BULLETINS.

The snow bulletins issued by the climate and crop sections in the Rocky Mountain and Plateau regions were more complete during the winter of 1903–4 than in any previous year, owing in a large measure to a plan of cooperation with the General Land Office, whereby was secured the aid of a large number of forest-reserve officers in reporting the depth of snow, more particularly at high altitudes. As these section snow bulletins show the amount of snow in the mountains, they afford a reliable basis of estimating the probable water supply and flow of streams for the succeeding spring and summer, and are therefore of much value to the important interests affected thereby.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

With no increase in the allotment for work in this direction, a repetition of the remarks in the annual report of last year would nearly cover the present situation. All that it was possible to do with available funds has been done, and every opportunity for extension where it could be done without exceeding the appropriation has been embraced.

There is a slight increase (61) in the number of places receiving daily forecasts by telegraph or telephone at Government expense; and as these points are, as a rule, selected on account of their eligibility as centers of distribution, the forecasts have been distributed in many sections not heretofore supplied with this information.

About 200 addresses were dropped from the emergency warning list, which has been revised and now provides for the distribution of special warnings of tropical hurricanes or storms and cold waves of unusual severity to postmasters at 6,152 points, who post the bulletins in their offices for the benefit of the public and in many instances telephone the warnings to adjacent points having special interests to be protected.

The railway telegraph and train services have continued in operation, supplying in the aggregate over 5,000 railroad stations with the daily forecasts, which are bulletined in the waiting rooms for the benefit of the employees and the traveling public.

Comparatively little change is shown in the number of card forecasts issued daily. This portion of the work has been so carefully examined into in previous years that nearly every post-office which could be reached in time to make the predictions of value is now being served. As mail schedules are changed the lists are modified, and as a rule the number added about equals that discontinued. Postmasters continue their cooperation in this, as well as in the Rural Free Delivery Service, and in a large number of instances have extensive lists to which the card forecasts are distributed daily. Action was taken to prevent the printing of names of individuals or firms on cards in connection with the forecasts. The Bureau is now free from this annoying advertising feature, and, so far as known, the cards as now issued contain nothing but the official forecasts, with occasionally a date and the name of the center from which the cards are distributed. The stand taken by the Bureau in this matter resulted in the loss of the cooperation of a few of the oldest distributors, who kept up the work on account of its advertising possibilities; but arrangements were quickly effected whereby others took up the work, or the substations were supplied from adjacent centers.

Through several causes the number of addresses on the rural free-delivery lists has been largely decreased as compared with that of the previous year, owing principally to the discontinuance of the afternoon forecast distribution from Columbus, Ohio, and the transfer of a large portion of this work in Iowa from the rural free delivery to the free telephone service. There is now available sufficient data to enable us to extend the rural free-delivery distribution, when practicable, to every route on which the carrier leaves the distributing office at an hour sufficiently late to receive the morning forecasts by telegraph from the district center.

The rural telephone lines are now the best and most economical means of distributing weather information. The forecasts are quickly disseminated, cover a large territory, and at little or no expense to the Government. Through arrangements made between the Weather Bureau officials at Cleveland and Columbus and two of the great trunk telephone lines, the daily morning forecasts are now available for the use of more than 100,000 subscribers in the State of Ohio, and the records at hand indicate that nearly one-half of that number are taking advantage of this opportunity to get the forecasts in their homes within a few minutes after their preparation at the district center. Officials of telephone companies operating lines in other States are rapidly signifying their desire to cooperate in this work, and it may be safely stated that the close of another fiscal year will show a gratuitous distribution of daily forecasts over the greater proportion of all independent telephone lines between the Atlantic seaboard and the western borders of Kansas, and as far south in the Middle West as the northern portion of Texas. The general manager of one of the largest independent lines in the State of Ohio stated in a circular letter to the managers of his exchanges that "intelligent handling of these reports will do much to make your service attractive, and whenever your service is attractive it is popular, and whenever popular it is a revenue producer." As these independent lines are merged with the long-distance companies the necessity for telegraphic forecasts to individual exchanges will cease to exist, making it possible to further extend the

distribution over rural free delivery lines into agricultural sections not now supplied with the forecasts.

The following statement shows the distribution by States and Territories and the changes, as compared with work of the previous year:

Distribution of daily forecasts and special and emergency warnings.

State or Territory.	At Government expense.			Without expense to United States by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warnings.	Mail.	Rural free delivery.	Telephone.	Railroad telegraph.	Railroad train service.
Alabama	23	4	139	1,175	257	107	83	12
Arizona	3	1	0	0	0	1	0	0
Arkansas	19	8	102	541	249	97	5	0
California	128	10	0	2,549	2,218	35	0	0
Colorado	17	67	39	980	1,016	1,889	0	7
Connecticut	11	3	49	1,074	100	0	15	151
Delaware	9	0	0	36	520	0	41	0
District of Columbia	0	0	0	1,199	0	0	0	0
Florida	27	127	61	917	0	42	91	0
Georgia	39	39	241	1,527	1,532	30	222	41
Idaho	10	1	0	371	0	4	0	17
Illinois	109	24	468	3,082	6,783	7,962	115	459
Indiana	93	16	208	1,913	5,488	6,658	68	287
Indian Territory	7	0	4	194	0	630	0	0
Iowa	168	30	400	1,730	7,667	51,083	13	0
Kansas	69	9	186	889	4,187	1,164	15	15
Kentucky	41	34	96	2,095	75	3,606	18	0
Louisiana	26	45	61	921	0	28	0	0
Maine	21	4	40	1,107	920	4	0	77
Maryland	26	4	42	1,778	1,384	15	101	0
Massachusetts	24	20	63	3,040	10,025	12	1	331
Michigan	115	21	379	4,894	4,888	4,208	253	457
Minnesota	62	18	196	1,961	2,342	1,744	13	0
Mississippi	55	6	118	703	0	49	6	0
Missouri	84	10	240	5,254	6,581	1,505	25	0
Montana	15	20	18	499	0	5	0	0
Nebraska	63	9	221	1,110	1,227	1,133	0	0
Nevada	3	0	0	205	0	0	0	0
New Hampshire	18	1	34	1,184	1,205	0	0	31
New Jersey	23	25	45	1,219	255	3	189	0
New Mexico	3	3	0	15	0	84	7	0
New York	106	68	365	7,549	9,359	3,467	363	168
North Carolina	56	20	189	1,131	268	24	1	16
North Dakota	16	9	99	0	258	74	0	0
Ohio	136	89	437	7,951	6,693	46,328	37	17
Oklahoma	7	2	13	214	0	2,596	9	0
Oregon	16	2	0	689	600	0	0	104
Pennsylvania	59	18	367	4,299	485	1,525	660	0
Rhode Island	4	0	12	105	0	1	0	28
South Carolina	34	5	109	1,123	456	193	30	23
South Dakota	33	19	77	800	195	2,981	0	0
Tennessee	43	11	291	1,534	1,370	217	23	2
Texas	57	66	240	1,769	1,583	259	154	0
Utah	14	62	0	372	290	6	0	0
Vermont	10	1	46	547	100	0	8	13
Virginia	43	9	96	1,572	228	118	60	96
Washington	21	5	0	737	876	8	0	29
West Virginia	18	11	55	987	232	1,619	18	26
Wisconsin	85	24	298	1,952	1,687	10,787	0	16
Wyoming	7	3	8	112	40	1	11	0
Total June 30, 1904	2,076	983	6,152	77,605	83,639	152,302	2,655	2,423
Total June 30, 1903	2,015	926	7,096	78,164	97,648	28,251	3,087	2,423
Changes	+61	+57	−944	−559	−14,009	+124,051	−432	0

THE MOUNT WEATHER METEOROLOGICAL RESEARCH OBSERVATORY.

At Mount Weather, Va., it is proposed to make and send out the apparatus for the exploring of the atmosphere to altitudes of 3 to 10 miles. In this work it is probable that many balloons will be simultaneously liberated from different stations, so as to get records of storms and of

cold waves from their four quadrants. With the knowledge thus gained of vertical gradients of pressure and of temperature, it will doubtless be possible to gain a better understanding of the mechanics of storms. This exploration will be useful in determining how near right are those who believe that change in temperature other than seasonal is mainly a function of the mechanics of the lower atmosphere—that portion lying below the 10-mile level; that in the study of those aberrations of climate called "weather" investigators need concern themselves only with the atmosphere near the earth; and that variations in the condition and in the intensity of the many forms of solar radiation are inappreciable in their effect on the weather of the earth.

With observations from the magnetic, the electric, and the solar physics observatories which the Department is now building, and which will be equipped with the most approved appliances, opportunity will be given to those who believe that the cyclonic or anticyclonic whirls that constitute storms or cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the opinion of the writer that the synchronism of changes in the activity of the chromosphere of the sun and the weather of the earth has not yet been established with sufficient definiteness to be of benefit to the forecaster, but a working hypothesis has been formulated which stimulates thought, study, and investigation. This fact must be credited to the patient work of Prof. Frank H. Bigelow. Even those who differ from him in their conclusions relative to the association between astrophysics and meteorology must admit that the fertility of his thought and his earnest seeking after the problems which, when solved, shall raise meteorology from empiricism to a closer approach to an exact science, have been highly beneficial. The study of storms has too long been made from a single view point. Daring minds are needed, even those that are willing to take a considerable hazard in the hypotheses which they are willing to lay down and attempt to demonstrate: for to doubt is to investigate. New truths are usually discovered by working inductively along conventional lines, but some of the greatest principles in nature have been made known to the world by deductive reasoning and by the assumption of a hypothesis that could not at the time be demonstrated. Due deference must be given to each other's opinions, and all must strive earnestly for the elucidation of the many difficult problems that now confront the meteorologist.

LINES OF PROPOSED INVESTIGATIONS.

It is proposed to make the research at Mount Weather catholic in its broadness; to look for the truth, and not to despise its source or the means of its conveyance; to discuss meteorological observations from the point of view of their relations to solar physics; to select meteorologic and magnetic elements and compare them with solar observations; to carry on research in the allied subjects of radiation, atmospheric electricity, ionization of gases, radioactivity, etc. Progress in knowledge of the effects of the sun's actions upon weather conditions depends upon introducing more refined processes than have generally been assigned to meteorology. It is hoped to determine the nature of the alliance between meteorology and solar physics. The atmosphere of the sun and of the earth, together with the connecting radiations, will be studied as one branch of science having common interests, which may be designated as cosmical meteorology.

In the seven buildings at Mount Weather the Weather Bureau will have the most approved apparatus for measuring atmospheric electricity and magnetism, for measuring the solar radiation in the spectrum, for registering the sun-spot areas, the prominence output, and the extent of the faculæ. These are all valuable as registers of the solar energy, which, falling upon the earth, may play a part in stirring up the atmosphere and producing our weather.

INTERPRETING THE LANGUAGE OF THE SUN.

The climate and crop conditions from year to year depend largely upon the invisible and subtle solar radiations, known to exist as waves, like those used in wireless telegraphy. The space between the sun and the earth—that is, the cosmical ether—is filled with wireless messages which science is laboriously learning to interpret. Its votaries do not understand the solar code very well, and the process of deciphering it is like that of learning to read the Babylonian inscriptions, namely, by putting this and that together, learning to read a bit here and there, by intercomparisons, trial, and failure, till at length the language of the sun shall be understood. The time may come when it may be possible to interpret the seasonal weather from year to year in advance. It has not yet arrived. The sun moves leisurely through its cycles and the terrestrial conditions seem to follow loosely. At present all available information concerning these matters comes in scattered form from observatories, in reports two or three years old. It is necessary, therefore, to have instruments, trained research observers and computers, and a discussion of results, subject to the direct control of the Weather Bureau.

BUILDINGS COMPLETED AND PROJECTED.

During the past year the main building of the Weather Bureau observatory has been completed, the power plant and the building from which balloon ascensions and kite flights are to be made have been erected, and the magnetic buildings started. It has been found that the rocks are entirely free from magnetism, and that the field is uniform, so that it is a suitable place on which to locate a magnetic observatory. A physical laboratory for electrical and radioactive effects is being planned, the erection of which will take place during another year. Finally, a comprehensive physical observatory for photographing the sun directly and through the spectrum, for measuring the radiation energy by actinometry and bolometry, with their allied equipment, will be required. This complex institution must grow up slowly; as plans can be matured along the best modern lines, our assistants must be trained to work in several lines on a harmonious general plan, and the results must be carefully studied as the science progresses.

CONVENTION OF WEATHER BUREAU OFFICIALS.

Under the authority of the Secretary of Agriculture, a convention of Weather Bureau officials was held at Peoria, Ill., in the audience room of the Bradley Institute of Technology, on September 20, 21, and 22, 1904. It is the custom to hold similar conventions once each three years. The character of the papers read and the discussions that followed were of an unusually high order. Particular effort was made to contribute to the science of meteorology, as well as to discuss methods

of utility. Several important results were obtained which will, without doubt, contribute to both the science of meteorology and the efficiency of the weather service.

Synopses of the papers read follow. A full report of the convention, including all of the papers in full and the discussions relative thereto, will be issued as soon as the work can be edited.

Laboratory Work in Meteorology, by Prof. A. G. McAdie: Laboratories essential in all courses of the applied sciences.—Meteorology to be the most important of the applied sciences.—Equipment of laboratory a measure of the standing of the university.—A laboratory containing only first-order station instruments does not meet the demand of the day.—Less routine work and more individual contributions.—Necessity of expressing clearly results obtained.—Teachers of science not familiar with meteorology.—Out-of-door work.—Movements of air on large scale and on small scale.—Arousing an interest in the students.—More important to understand the physical processes at work and to have clear conceptions of a few things than to maintain elaborate records or attempt long courses in reading.—Problems awaiting investigation.

The Mount Weather Research Observatory, by Prof. F. H. Bigelow: Need of a modern research observatory for meteorology in the United States.—Recent advances in physics which concern meteorological problems.—Equipment of the proposed observatory at Mount Weather.—Problems and observations which can be undertaken.—Relation of the data to processes in forecasting the action of cyclones and anticyclones.—Problem of long range forecasts of the seasons and the synchronism between solar and terrestrial actions.

Errors of Meteorological Instruments and Lines along which Improvement should be Sought, by Prof. C. F. Marvin: Three general classes of errors mentioned.—Accuracy of mercurial barometers and thermometers.—Clock errors in automatic instruments.—Discussion of effects of thermometer errors on the psychrometer at certain temperatures.—Construction of rain gages, errors of exposure, action of wind, etc., considered.—Difficult problems in snow measurements.—Errors of anemometers at high and unusual velocities.—Measurement of sunshine.—Lines of improvement discussed.

Long Range Forecasts, by Prof. E. B. Garriott: Refers to theories regarding weather periodicities dependent upon lunar or planetary influences, and pronounces them theories of faith and not of practice.—Summarizes results obtained by comparisons of maximum and minimum sunspot periods with the phenomena of the earth's atmosphere, and states that the next advance in meteorological science must result from extensive research in solar physics and terrestrial magnetism and comparison of solar and terrestrial phenomena.—Mentions means proposed to accomplish world-wide plan of observation permitting systematic study of the problem.

Seasonal Forecasts, by Prof. A. G. McAdie: Improvement of daily forecasts.—Experience at San Francisco; rain falling on typical fair weather maps; map classifications insufficient.—Seasonal types of pressure distribution.—The individual disturbance in its relation to the seasonal condition.—Permanent pressure areas and their relation to the season's character.—Typical wet winters on the Pacific coast.—Individual disturbances are by-products of the larger air movements; therefore the character of the individual high or low will vary more or less with the swinging of the larger pressure areas.—True normal conditions rare.—Ability to forecast the abnormal condition is the real test of the forecaster.

Amplification of Forecasts for Benefit of Shippers of Perishable Products, by Dr. W. M. Wilson: Importance of amplified forecast to large industrial and commercial enterprises.—Extent to which their needs are met at present, and practicability of specializing for their benefit.—Necessity of a definite view on the part of the forecaster regarding the interests to be thus served.—Terms proper to such forecasts.—Review of other special services now in operation.—Suggested methods of amplification.

An Aid in Forecasting, by Mr. F. H. Brandenburg: Disadvantages of a district forecaster under present methods through lack of convenient means of studying local weather signs at outlying stations.—Recommends compilations of prevailing wind directions, temperature changes, clouds, and pressure changes for twelve and twenty-four hour periods before and after precipitation.—Advantages of such compilation.

Forecasting Fogs on the Gulf Coast, by Mr. B. Bunnemeyer: Periods of and areas covered by dense formation.—Diurnal periods of maximum and minimum density.—Temperature, air pressure, and wind direction in connection with fogs.

A Popular Account of the Countercurrent Theory of Storms, by Prof. F. H. Bigelow: Leading meteorological theories and their defects.—Observations which have contributed to the new theory.—Cause of the counter currents in the general circulation of the atmosphere.—Local circulation in cyclones and anticyclones.—Equilibrium of temperature.—Interchange of inertia.—Relation of the theory to forecasts.

Variations in Insolation and in the Polarization of Blue Sky Light during 1903 and 1904, by Mr. H. H. Kimball: Observations in Washington and their comparison with those in other cities.—Cause of diminution of solar insolation in 1903.—Effect of variation of solar energy on climatic conditions and plant life.—Value of solar investigations at Mount Weather.

A Possible Method for Determining the Directions and Velocity of Storm Movement, by Mr. E. H. Bowie: Variations from the average direction and velocity of movement of cyclonic areas responsible for a large percentage of errors in forecasting.—General statement that storms follow lines of least resistance of small practical value without definite rules for determining such lines.—Brief summary of views of leading authorities as to the main laws of control of cyclonic movement.—Studies of erratic storm movement by the writer, disclosing the influence exerted by unequal pressure distribution surrounding the area of low pressure, and the presentation of a working basis for determining the value of such control upon the future movement of the storm.

Temperature Forecasts and Iron Ore Shipments, by Mr. H. W. Richardson: Temperature an important consideration in the shipment of iron ore.—When iron ore is frozen, it can not be economically transferred from cars to boats; thawing by steam expensive, also causes delays, which can be averted by advance information of freezing temperature.—Practical application at Duluth.

Distribution of Forecasts by Telephone, by Dr. G. M. Chappel: List of telephone companies in Iowa.—Plan of cooperation.—Practical results.

Practical Rules for Forecasting Flood-Crest Stages for Cairo, Ill., by Mr. P. H. Smyth: Difficulty of crest-stage forecasting.—Character of the data upon which forecasts are based.—Possibility of predicting the intensity of floods two or three months in advance of their occurrence.—Method of applying the tabulated data.—Brief history of the flood at Cairo in the spring of 1897.—Time of flood crests from Cincinnati, Chattanooga, Nashville, and St. Louis to Cairo.

The Columbia River, by Mr. E. A. Beals: Its discovery and commercial importance.—Drainage basin, extent and character.—Precipitation over watershed.—River stages, including The Dalles Hydrograph.—Causes of floods, their frequency and duration.

Some Diurnal Periodicities in the Climatic Factors at Baltimore, by Dr. O. L. Fassig: A diurnal period will be shown for temperature, pressure, humidity and vapor tension, rainfall (frequency and amount), wind velocity and direction, cloudiness and sunshine, and thunderstorms and atmospheric electricity.—Discussion based on series of ten years of hourly observations made at the Baltimore station.—Diurnal periods graphically shown by means of a system of "isopleths."

Instruction and Research by Weather Bureau Officials, by Prof. Cleveland Abbe: In this address the author shows what has been done for meteorological education during the past thirty years by the Bureau or through its influence.—He examines the present condition of this subject in this country and considers its future prospects.—He shows that progress in forecasting means not only education in the physical sciences but research, and illustrates this by recent examples.—Finally he shows what research means, how it is to be fostered, and especially how it can be carried on at a well-equipped central meteorological observatory like that at Mount Weather.

Phenological Observations at Wauseon, Ohio, by Mr. J. Warren Smith: Temperature and precipitation at Wauseon, Ohio, since 1876, and their relation to the blossoming of fruit trees.—Average yield per acre of principal farm fruits and crops. (This paper will be accompanied by charts.)

A Study of the Rainfall on the West Florida Coast, by Mr. B. Bunnemeyer: Summary of rainfall data for twenty-four years, with charts.—Ratio of day rain storms to night rain storms.—Hours of greatest and of least frequency of showers.

Climatology of Porto Rico, by Mr. W. H. Alexander: Topography.—Temperature.—Rainfall.—Humidity.—Prevailing winds, etc.

Monthly Statement of Averages for Rural Press, by Mr. W. S. Belden: Form similar to 1079-Meteorological, based on data from all observation stations within

section, to be prepared at section centers.—Such data for ten years or more now available.—Data should be concise and plainly stated.—Extreme values for important agricultural districts to be stated.—Time of issue and use of by weekly newspapers and newspaper unions.—Result of experiments.

Irregularities in Frost and Temperature in Neighboring Localities, by Dr. I. M. Cline: Marked variations of temperature in different localities in immediate neighborhoods.—Occurrence of "frost patches," or the irregular effect where small areas scattered over fields have suffered much greater damage than other parts of the same field.—Character and color of soils and their influence on insolation and radiation have much to do with the occurrence of frost and explain the "frost patches."

Former Conventions of Weather Bureau Officials, by Mr. James Berry: Brief mention of former conventions and of the benefits resulting therefrom.

WIRELESS TELEGRAPHY.

The Department of Agriculture, through the Weather Bureau, was one of the first of the Government Departments to take up, systematically, experimentation in problems concerned with the development of wireless telegraphy. By this action research into the physical problems concerned in transmitting messages through the medium of ether waves was greatly stimulated in this country. Probably one of the best, if not the best, instruments anywhere made for the receiving of wireless messages had its inception in the experimental work of the Weather Bureau.

Recently a Board, to consider the whole problem of wireless telegraphy and the relation of the Government thereto, was appointed by the President. Its conclusions and recommendations follow:

CONCLUSIONS.

The conclusions of the Board are—

That the science of wireless telegraphy has been advanced by the able and persistent work of the Signal Corps of the Army and the Weather Bureau of the Department of Agriculture, as well as by the experimental work of the Navy Department;

That wireless telegraphy is of paramount interest to the Government through the Navy Department, and that its use by the Signal Corps of the Army for communication between military posts of the Army and other necessary links will be necessary both in peace and war, and that such use shall be unrestricted. When interference seems probable between stations of the Navy and War Departments, the question involved shall be mutually settled by representatives of the two Departments;

That coastwise wireless telegraphy is not a necessity for the work of the Weather Bureau of the Department of Agriculture, provided that the necessary meteorological data for that Department can be collected by the stations of the Navy Department from ships at sea and by them sent to the Weather Bureau of the Department of Agriculture;

That the maintenance of a complete coastwise system of wireless telegraphy by the Navy Department is necessary for the efficient and economical management of the fleets of the United States in time of peace and their efficient maneuvering in time of war;

That the best results can be obtained from stations under the jurisdiction of one Department of the Government only, and that representatives of more than one Department should not be quartered at any station;

And finally the Board concludes that the Government must take the necessary steps to regulate the establishment of commercial wireless-telegraph stations among the States and between nations.

RECOMMENDATIONS.

In order that the above conclusions may be carried into effect, the Board recommends—

That the Signal Corps of the Army be authorized under its chief to establish from time to time such wireless stations as he may deem necessary, and that they do not interfere with the coastwise wireless-telegraph system of the Government under control of the Navy Department; and further, that the Chief Signal Officer be

requested to inform the Navy Department what stations of its system may be utilized to transmit messages for the Signal Corps or other bureaus of the War Department, and that representatives of the Signal Corps of the Army and the Bureau of Equipment of the Navy Department be at once requested to draw up such rules as will insure the efficient and harmonious carrying into effect of the above recommendations.

That the necessary steps be taken to have the Weather Bureau of the Department of Agriculture turn over to the Navy Department all coastwise wireless-telegraph apparatus now under its control, and such material as it may have in its possession which can be utilized by the Bureau of Equipment of the Navy Department, and that proper transfers of funds for this purpose be made;

That the Weather Bureau of the Department of Agriculture furnish to the Hydrographic Office of the Navy, and to the naval wireless-telegraph stations, or to other portions of the public service, such meteorological data as it or they may desire at no cost to them;

That the Department of Agriculture shall continue the work of its meteorological vessel-reporting and storm-warning stations, as now constituted and provided for by law, and continue the control of seacoast telegraph systems, except wireless systems;

That the necessary steps be taken that the Navy Department may equip and install a complete coastwise wireless-telegraph system covering the entire coasts of the United States, its insular possessions, and the Canal Zone in Panama;

That the Navy Department be directed to receive from the Signal Corps of the Army, at such points as may be requested by the Chief Signal Officer of the Army, all messages for army posts within their radii, and transmit them under such rules as may be agreed upon by the representatives of the Signal Corps and Bureau of Equipment, without cost to the Signal Corps of the Army;

That all meteorological reports from vessels of war or commerce or other sailing craft, now being forwarded direct to the Hydrographic Office of the Navy, shall be forwarded direct to the Weather Bureau, and the control of ocean meteorology be transferred to the Department of Agriculture, which already has ample law for doing this work;

That the estimates for the support of the Hydrographic Office of the Navy, or any other office of the Navy, for the next and succeeding fiscal years, do not contain any provision for the making of ocean forecasts, or for the publication of meteorological data, other than such as may be needed by the Hydrographer of the Navy for use on the pilot and other charts, which data shall be furnished by and credited to the Weather Bureau;

That it is the opinion of this Board that no meteorological work need or should be done by any portion of the Navy for the purpose of publication, or for the making of forecasts or storm warnings; that all such duties, being purely civil, should devolve upon the Weather Bureau of the Department of Agriculture in accordance with the organic act creating that Bureau;

That the wireless stations of the Navy Department shall, without charge to the Agricultural Department, receive and promptly transmit to the ocean or to islands, or to other places where the information can be made useful, the storm warnings of the Weather Bureau;

That the Navy Department shall request all vessels having the use of its wireless stations for the receipt of messages, to take daily meteorological observations of the weather when within communicating range and to transmit such observations to the Weather Bureau, through naval wireless stations, at least once daily, and transmit observations oftener when there is a marked change in the barometer; and that there shall be no charge against the Agricultural Department for these observations or for the transmission thereof;

That representatives of the Department of Agriculture and the Bureau of Equipment of the Navy Department be directed to prepare the necessary rules for the harmonious and efficient carrying on of the above recommendations.

We recommend that as fast as the naval wireless-telegraph stations are put in operation the Navy Department be directed to receive and transmit through these stations, free of charge, all wireless messages to or from ships at sea, provided such stations do not come in competition with commercial stations, until such time as Congress may enact the necessary legislation governing this subject.

In asking for legislation on this point, the Board desires to invite attention to the fact that where wireless stations are needed for the merchant marine, as a rule the Navy will also require them. The Board believes it to be in the interest not only of governmental but public economy and efficiency to permit the naval stations to handle the public service, for in the present state of the art but one station is desirable for the public interests in such places. As the needs of the Navy are paramount on account of the problem of national defence, private stations should not be

allowed to locate to the disadvantage of the former. Moreover, there is at present no public need for multiplication of stations at these points.

It is admitted, however, that there may be special cases where private stations can serve a useful purpose, and the Board believes that the Department of Commerce and Labor should have the duty of issuing licenses in such cases under such regulations as will prevent interference with stations necessary to the national defence. All private stations in the interior of the country should also be under supervision of the Department of Commerce and Labor.

This method of placing private stations under full Government supervision is desirable in order to regulate them for their mutual and the public welfare, as well as from considerations of national defence. Aside from the necessity of providing rules for the practical operation of such stations, it seems desirable that there should be some wholesome supervision of them to prevent the exploitation of speculative schemes based on a public misconception of the art.

It is believed that invention and private enterprise should be encouraged in every legitimate way, and it is the policy of the Navy Department to do this. It has the means of assisting inventors that no other Department has, and it believes that in order for it to lead the navies of the world in this matter, which is of great importance to the national defence, every reasonable facility should be given inventors, while at the same time it is working out the problems of the application of their inventions to its requirements in times of peace and war.

To prevent the control of wireless telegraphy by monopolies or trusts, the Board deems it essential that any legislation on this subject should place the supervision of it in the Department of Commerce and Labor.

Because international questions may arise, due to the fact that the use of wireless-telegraph stations in our own possessions may affect the use of similar stations in foreign countries, it is desirable for the Congress to enact legislation which will enable the Government properly to handle such cases; a failure to do so may seriously embarrass the Government at some future time.

It is thought that the legislation recommended in placing private stations under the supervision of the Department of Commerce and Labor will also cover this case.

In conclusion, the Board deems it essential that the Executive take such action as in his judgment seems wise to prevent the erection of private wireless-telegraph stations where they may interfere with the naval or military operations of the Government until legislation may be had by Congress on this subject.

Appended hereto are two extracts from the Revised Statutes, marked "W" and "X," which related to the operation of Government telegraph lines; also a decision of the Supreme Court, marked "Y," and the final protocol of the Preliminary Conference of Wireless Telegraph. held in Berlin in August, 1903, marked "Z." [a]

Very respectfully,

R. D. Evans,
Rear-Admiral, U. S. Navy,
Representing the Department of Commerce and Labor.

H. N. Manney,
Rear-Admiral, U. S. Navy,
Representing the Navy Department.

A. W. Greely,
Brigadier-General, U. S. Army,
Representing the War Department.

Willis L. Moore,
Chief U. S. Weather Bureau,
Representing the Department of Agriculture.

Joseph L. Jayne,
Lieutenant-Commander, U. S. Navy,
Representing the Navy Department.

MONTHLY WEATHER REVIEW AND WORK OF THE EDITOR.

Prof. Cleveland Abbe's time has been wholly occupied in collecting and preparing material for the Monthly Weather Review and in preparing and delivering a course of lectures on various problems in physical meteorology. The Monthly Weather Review has appeared as

[a] The papers referred to in this paragraph are omitted from this report.

promptly as practicable about six weeks after the close of the month whose name it bears. The salient features of the principal articles published in the Reviews for June, 1903, to June, 1904, are worthy of review in this report. From notes furnished by Professor Abbe the following comments are made:

W. N. Shaw: "La lune mange les nuages." A note on the thermal relations of floating clouds (June, 1903). In this the author, who is the chief of the Meteorological Office of London, shows graphically the effect of a slow descent of the air in evaporating the clouds, a phenomenon that occurs regularly every night.

Prof. C. F. Marvin: "The Weather Bureau seismograph" (June, 1903). This describes the apparatus now established at the Weather Bureau and the sources of error in its records. This apparatus was invented by Omori, of Japan, and manufactured by Bosch, of Strasburg. This article has been highly praised in Europe and reprinted by the manufacturer for general use. During the last year a number of earthquake waves have been recorded by it, and the records have been published in the Weather Review. Professor Marvin states that it needs to be supplemented by another smaller apparatus specially designed for the detection of short, minute waves. The present one is designed for the long, slow waves that frequently run several times entirely around the earth before their energy is spent. The Omori apparatus is said to be much more sensitive than the photographic horizontal pendulum of Milne, which is employed at Baltimore, Toronto, and Victoria, but it is apparently not so sensitive as the magnetic needle supported on a quartz fiber, as in the magnetic observatory at Cheltenham, England. The records of the Milne seismograph at certain stations are said to have demonstrated that the areas of high and low atmospheric pressure produce perceptible tiltings of the earth's surface, but the Omori instrument at Washington does not show this, possibly because its location in the basement of the main building does not isolate it sufficiently well from local changes due to temperature and the passage of wagons and individuals.

Harvey N. Davis: "Observations of solar radiation with the Angström pyrheliometer at Providence, R. I." (June, 1903).

H. H. Kimball: "Observations with the Angström pyrheliometer" (July, 1903). These reports were referred to in my previous annual report as having been presented and about to be published. Since that time they have been published in full, and have been followed by a general discussion of the whole subject of the sudden variation in the quantity of heat received at the earth's surface that occurred during 1902–3. Some have maintained that this change is due primarily to a change in the amount or quantity of heat that issues from the sun itself. Others, with more plausibility, maintain that it is due to a sudden accession of moisture, haze, or dust in our own atmosphere, and that the changes in the solar radiation or absorption are too small to have caused this change as measured at the earth. Mr. Kimball has continued his own series of observations during the past year at Washington, and if his work is maintained for several years it will doubtless give us additional information. It is very important that the bolograph records secured by Professor Langley should be duplicated by corresponding work at some very dry station having much clear sky, such as are found in our Rocky Mountain and Pacific coast regions.

W. N. Shaw: "On curves representing the paths of air in a special type of traveling storm" (July, 1903). The author deals with a special assumed case in which the speed of the air is assumed to be uniform over the whole area of the storm, although the direction varies from point to point. The isobars are assumed to be true circles, and the wind directions are tangential to them; the center describes a straight path with the same speed as the wind. Many of the conclusions drawn from these assumptions agree with the observations of actual storms. He postpones the consideration of the influence of ascending and descending currents to his next paper, "General circulation of the atmosphere." This has already been received and published in the Review for June, 1904.

D. T. MacDougal: "Soil temperatures and vegetation" (August, 1903). This is a study in the relation between climate and plant growth, and represents the results of several years of work. It would appear that the temperature of the soil is more important than the temperature of the air.

C. G. Knott: "Solar radiation and earth temperatures" (October, 1903). A novel feature of this paper consists in the computation of the accumulation of heat, or the total quantity of heat in the soil at any time of year, as obtained by integrating the expression for the quantity present in each successive layer of soil. The computation shows that at the beginning of September there is a maximum quantity of heat below the surface of the ground and at the beginning of March there is a minimum

quantity. At Edinburgh, Scotland, this difference amounts to over 1,200 units per square centimeter, or nearly 8,000 units to the square inch.

Prof. F. H. Bigelow: "Studies on the circulation of the atmospheres of the sun and of the earth." (1) The circulation of the sun's atmosphere (October, 1903); (2) The synchronism of the variations of the solar prominences with the terrestrial barometric pressures and temperatures (November, 1903); (3) The problem of the general circulation of the atmosphere of the earth (January, 1904); (4) Values of certain meteorological quantities for the sun (February, 1904); (5) Results of the nephoscope observations in the West Indies during the years 1899–1903 (April, 1904); (6) Circulation in cyclones and anticyclones (May, 1904); (7) Average monthly vectors of the general circulation in the United States (June, 1904).

This long series of papers by Professor Bigelow presents the results of several years of work. It is the opinion of Professor Abbe that the most important conclusion to the meteorologist is the presentation of the fact that in certain portions of the globe the oscillations of temperature are similar to those of the solar phenomena, such as sun spots and prominences, while in other parts of the globe they are opposite, and that about an equal number of regions show no decided agreement or opposition. He is of the opinion that terrestrial weather phenomena are the direct result of changes in the pressure and circulation of the earth's atmosphere, and it is not yet certain that these have any connection with the sun. Some are inclined to believe that changes in the sun are the direct or indirect cause of these terrestrial changes. Others believe that the latter would exist even if the sun's radiation were absolutely uniform, and that they represent hydrodynamic and thermodynamic phenomena confined to the atmosphere itself.

Another interesting result of Professor Bigelow's work is presented in his article on the nephoscope work in the West Indies, in which he shows the variation from month to month in the directions of motions of the winds and clouds. The season of hurricanes is distinguished by a special disturbance of the atmospheric circulation. The level of the maximum horizontal velocity changes systematically throughout the year. The mean altitude at which the westward drift reverses to the eastward drift is apparently above 6 miles in the summer months. The strata, from 4 to 6 miles high, are those chiefly concerned in causing the formation of hurricanes.

Alexander G. McAdie: "Mount Whitney as a site for a meteorological observatory" (November, 1903). This is a report of an expedition by Professor McAdie to the summit of Mount Whitney. The altitude of the mountain has been determined barometrically by a number of observers. Professor McAdie's result is 14,515 feet, but the levelings reported by Prof. Joseph N. LeConte since Professor McAdie's work give 14,434 feet.

Prof. Dr. J. M. Pernter: "Methods of forecasting the weather" (December, 1903); "Promotion of meteorology" (May, 1904). These two articles present an excellent summary of the arguments against the so-called long-range forecasts by means of planetary meteorology, and will do much to stem the tide of popular ignorance and superstition on this subject.

Oliver L. Fassig: "Kite flying in the Tropics" (December, 1903). This summarizes the results of meteorological work by Doctor Fassig on an expedition to the Bahamas under the auspices of the Geographical Society of Baltimore. A number of successful kite ascensions were made both from the land and the water, and the temperature, moisture, and wind were determined at various heights up to 4,000 feet.

G. C. Abbot: "Recent studies on the solar constant of radiation" (December, 1903). This is a most important publication in which for the first time meteorologists have been favored with quite reliable determinations of the absorbing power of the atmosphere for a number of specific wave lengths, ranging from the visible portion of the spectrum far down into the ultra red. A similar work by Professor Langley has been offered for publication, and a summary will appear in some future number of the Weather Review.

Prof. James Dewar: "Problems of the atmosphere" (January, 1904). The author computes the relative quantity of oxygen and nitrogen, carbonic-acid gas, and possible hydrogen up to the outer limit of the atmosphere, and gives important suggestions as to the origin of the aurora and its spectrum.

Gen. H. L. Abbot: "Disposition of rainfall in the basin of the Chagres River" (February, 1904); "Panama meteorology" (June, 1904). These form the conclusion of an important series of papers in which the meteorological data collected by the engineers of the New Panama Canal Company are subjected to discussion by one of the most prominent officers of the Engineer Corps of the United States Army. The great work of Humphreys and Abbot on the Mississippi River has been a standard for fifty years, and his work on the Chagres promises to hold an analogous position as regards that river.

Rev. Marc Dechevrens, S. J.: "Vertical component of the wind" (March, 1904). This article presents the results of observations for several years on the vertical movements of the atmosphere as recorded on the island of Jersey by the use of a special anemometer. The observations are very instructive, although it may be doubted whether they have anything but an extremely local application.

William B. Stockman: "The winter of 1903–1904." In this article Mr. Stockman gives a detailed record of departures from normal temperatures during the past winter. From New England westward to the Missouri Valley and southwest to the east Gulf States temperatures were generally below the normal. On the Rocky Mountain slope, the Plateau, and Middle Pacific districts temperatures were above normal.

Dr. Edgar Buckingham: "The amount of energy in a unit of light" (April, 1904). This is a very thoughtful paper revising our knowledge of radiant energy, and showing that to a certain extent we may calculate the temperature of a flame from its radiant energy, but the temperature of an ordinary body can scarcely be thus determined without involving undesirable assumptions.

E. L. Mosely: "The meteor of September 17, 1902" (April, 1904). The author collects the observations and calculates the path of this meteor. The sounds that emanated from it are, however, not explained by him.

R. Assmann: "The temperature of the air above Berlin" (April, 1904). The text and charts illustrate the results of the highest balloon and kite work, and give sections of the atmosphere showing the temperature day by day for fifteen months from October, 1902, to December 31, 1903. These are apparently the most accurate temperatures yet observed in the upper air, and show that at the height of 5,000 meters, or over 3 miles, the changes in temperature from day to day are surprisingly large, but very little less than at sea level. The so-called diurnal variation of temperature is of course very small, but the irregular oscillations, due to the passage of masses of warm air and cold air, are as large in summer as in winter. On the average there is a general inversion of the vertical temperature gradient; that is to say, the stratum between 500 and 2,000 meters has an average temperature a little higher than the strata above or below it. The level of freezing point varies between 3,000 meters and the ground. The international high balloon ascensions now being carried on in Europe on specified days promise to add more to our knowledge of the atmosphere than was obtainable by the use of high mountain stations; but both of these methods of investigation, as well as the kite work, have become of great importance. Each is specifically adapted to the investigation of some special problem.

S. A. Mitchell: "Pressure of light" (May, 1904). This is an exposition of the latest views accepted by experimental physicists as to the consequences of the well demonstrated fact that a beam of light, or any other form of radiant energy, exerts a pressure in the direction of the propagation. This pressure is inappreciable, when the body is large, in comparison with the attraction of gravitation, but becomes the most important item when the body is very small. By virtue of this pressure the finest dust of gaseous particles are repelled from the sun toward the earth and in all directions. When they impinge upon the outer boundary of the earth's atmosphere they may enter it temporarily and influence atmospheric and electric phenomena. These views have received their fullest development at the hands of J. J. Thomson, and at present the subject belongs to molecular and solar physics rather than to meteorology.

W. F. Tyler: "Sensation of discomfort" (May, 1904). The author has attempted to draw curves based upon personal observation showing under what conditions of temperature, wind, and moisture he experienced the greatest discomfort. His idea is quite analogous to that proposed by the editor some years since in which curves of perfect comfort were recommended. Either method seems to offer a convenient way of expressing something analogous to the so-called sensible temperature, and without involving the observer in any unsatisfactory theory.

The cooperation of so many physicists at home and abroad is gratefully acknowledged, and has contributed in an important degree in making the Monthly Weather Review of increased value to the service as well as to meteorology in general.

THE TEACHING OF METEOROLOGY BY WEATHER BUREAU OFFICIALS.

Meteorologists gratefully recognize the personal interest of the honorable Secretary of Agriculture in the general introduction of meteorology into the courses of study provided by the universities and higher technical institutions of the country. At his suggestion the mode of

teaching and the results obtained were made an important part of the work of the convention of Weather Bureau officials at Peoria, Ill., in September, 1904. At 14 educational institutions Weather Bureau officials, in addition to their regular duties and mainly outside of office hours, deliver courses of lectures on meteorology. The discussion at the convention brought to light the fact that a large amount of work is being done by Weather Bureau men in an educational way. The methods employed are determined by the different needs of the institutions receiving the cooperation of the Bureau, and range from impromptu talks to elaborately prepared lectures with suitable illustrations. The audiences included school classes, teachers' institutes, science associations, and business men's meetings. At many places regular and systematic courses are being given by Weather Bureau men, and at some of the leading universities a professor makes a specialty of the teaching of meteorology. We are anxious that it should be incorporated as a part of the science course in every university. I am of the opinion that some general study of meteorology should be required of persons who are fitting themselves to fill the position of civil engineer, mechanical engineer, geologist, or biologist, and that an elementary knowledge of meteorology and climatology is of prime importance in the study and cure of disease.

LECTURES BY PROFESSOR ABBE.

In addition to his work on the Monthly Weather Review, the editor, Professor Abbe, has delivered a course of lectures on meteorology to students who come to the Weather Bureau. These lectures should, perhaps, properly be considered as preliminary or introductory to those that may be given in future years at Mount Weather. One lecture of two hours' duration was given on consecutive Fridays from January to May, inclusive. The preparation of these lectures required much more time than was originally contemplated, and as the subjects were treated from a mathematical point of view it may be doubted whether they can properly be called popular. However, they presented the latest results of work done by some of the ablest meteorologists in the world. If they could be published they would perhaps be recognized as an extension of the knowledge collected by Hann in his Lehrbuch der Meteorologie. The publication of an English edition of this Lehrbuch is still greatly to be desired, but as the work is a herculean task it may perhaps be postponed until Professor Hann himself publishes a condensed edition of his volume.

ENCOURAGEMENT AND INCREASE OF EDUCATIONAL WORK.

The general subject of instruction in meteorology given by Weather Bureau men in the form of public lectures or college class work has been kept faithfully in mind. Every case worth mentioning has been noted in the Monthly Weather Review. Inspectors have been instructed to report fully as to the amount and character of the work and the possibility of increasing it. There is an increasing demand for class work in high schools and colleges. It is not likely that the Weather Bureau employees can fully respond to this demand, partly because of their want of training as teachers, but principally because of the absorption of their time in regular office work. It is to be hoped that our colleges and universities will establish proper positions for teachers of meteorology, and that some of our best men may fill

such places when retired from active service in the Weather Bureau. Meanwhile they are doing their best to respond to the demands made upon them.

LIBRARY.

The work of the library has been conducted on the same general lines as in recent years. On June 1, 1904, Dr. W. F. R. Phillips was succeeded by Mr. H. H. Kimball as librarian, climatologist, and supervising examiner.

The library is being used more and more as the work of the Bureau expands. Employees detailed to special lines of research need first of all to become familiar with the methods and results of others doing similar work. The library, therefore, becomes their starting point, and hence the necessity for having the books and pamphlets so arranged and indexed that all that relates to any given subject may be readily found.

As set forth in former reports, it has been the aim of the librarian to supplement the author index of books and pamphlets with a subject index, and this in turn with a bibliography of meteorological and allied topics made up from papers that appear in the periodicals of this and other countries. The bibliography is kept up to date, and most of the titles that are added to it are also published month by month in the Monthly Weather Review for the benefit of students. The subject index of books and pamphlets is still incomplete, however, and work upon it will be pushed during the coming year as fast as the resources of the library will permit.

The accessions during last year amount to 550 titles, of which 82 were by purchase and the remainder by exchange or gift. The total number of accessions now amounts to 24,680 books and 4,430 pamphlets, besides a number of miscellaneous works not catalogued.

Accessions are now limited to books and pamphlets bearing directly upon the science of meteorology. Many of these are the periodical publications of foreign governments and of scientific societies in all parts of the world; they contain so much that is of interest and value to meteorological students that it is plainly our duty to preserve them carefully.

A small collection of text-books, such as are required by observers in preparing for examinations for promotion, and also a few meteorological works of a more advanced character, is maintained at sta tions. Under the supervision of the library this collection of books is added to year by year as funds will permit. So many station officials are engaged in educational work in connection with high schools and colleges that a small library of this kind is necessary, although books are loaned to these officials from the central office library when practicable.

EXAMINATIONS FOR PROMOTION.

During the year 55 requests for examination were received by the supervising examiner and favorably acted upon. The subjects in which examinations are now given are arranged as follows:

1. For eligibility for promotion to the $1,000 grade: Arithmetic, English grammar, elementary meteorology.
2. For eligibility for promotion to the $1,200 grade: Algebra, elementary physics, plane trigonometry.

3. For eligibility for promotion to the $1,400 grade: Astronomy, plant physiology, advanced meteorology.

As a rule, all the subjects in a group are given at one examination. Of the 55 examinations held during the year 25 were on subjects in the first group, 21 in the second group, and 9 in the third group. Only five persons received less than the passing grade (70 per cent) on any subject.

Since one of the primary objects of these examinations is to elevate the educational standard among Weather Bureau employees, it is gratifying to note that the number of those who pass the examinations in the higher grades is increasing.

INSTRUMENTS AND EXHIBITIONS.

The Instrument Division is charged with the duties of providing, testing, adjusting, and supervising the installation of all meteorological instruments and storm-warning towers. During the past year the exhibits of the Weather Bureau at the Louisiana Purchase Exposition, St. Louis, were prepared and installed by the professor in charge of the division.

PRESENT STATUS OF STATION EQUIPMENTS.

The status of the instrumental equipment of stations at the close of business, June 30, 1904, was as follows:

One hundred and fifty-eight stations were completely equipped—that is, were supplied with instruments by means of which automatic records are made of the direction and the velocity of the wind, the duration of sunshine, the amount and the time of beginning and ending of rainfall, and, finally, the temperature and the pressure of the air. Of these stations the following were newly equipped with complete sets of apparatus, namely: Birmingham, Ala.; Modena, Utah (old station reequipped); Yellowstone Park, Wyo.; Maritime Exchange, New York; Brooklyn Eagle Building, Brooklyn, N. Y.; and Honolulu, Oahu, Hawaii. The number of completely equipped stations has been increased by twenty during the past year.

The following table shows the total number of the principal instruments in actual service:

Triple registers	166
Barographs	202
Thermographs	165
Tele-thermographs	8
Tipping-bucket rain gages	152
Electrical sunshine recorders	144
Photographic sunshine recorders	15

With one or two exceptions the stations that are not at present completely equipped are of slight importance, and, in general, have all the instruments necessary to the satisfactory performance of their work.

EQUIPMENT OF STORM-WARNING STATIONS.

The equipment of 26 selected stations with storm-warning towers and improved high-power lanterns was undertaken at the beginning of the year. The funds available for this were limited, and notwithstanding the fact that a considerable amount of other work was taken up, including the installation of an exceptionally high tower (115 feet)

at the Delaware Breakwater, Delaware, nearly all have been brought to a very satisfactory state of completion.

Almost a year is required in work of this kind, for the reasons that owing to the special nature of the towers, lanterns, etc., they are not carried in stock by contractors, but require to be manufactured after orders are placed, viz, after the beginning of the fiscal year. From sixty to ninety days are required for this purpose, and the shipment of towers to stations, the locations of which are often relatively inaccessible, consumes additional time. During this interim leases and other arrangements are made for title to the site of the towers, and bids for their erection and the installation of lights are obtained. Owing to the severity of the winters in the Lake regions it is necessary, in certain cases, to defer until springtime the erection and installation of towers and lanterns planned for during the winter.

At the close of business June 30, 149 steel towers, with improved auxiliary equipment, had been installed at as many stations distributed over the shores of the Great Lakes and the Atlantic and Pacific seacoasts.

High-power electric lanterns are installed at 77 stations, and improved oil lights at 68 stations. The towers at 3 stations are used for flag displays only.

The present plans contemplate the equipment of 10 additional stations, supplies for which have been ordered.

EXPOSITION WORK.

The preparation of the exhibit to be made by the Weather Bureau at St. Louis was actively taken up by the professor in charge of the instrument division, and practically all the apparatus and material required was boxed and ready for shipment February 1, 1904. Shipment was made a few days thereafter, and additional supplies, consisting of a special glass weather map, swinging chart frames (clusters), instrument cases, etc., were forwarded from Detroit, Mich. Nothing was injured or delayed in any way in transit. The work of installation began promptly on April 6 and was completed on April 29, the day before the opening, with the exception of the charging of the storage batteries and the installation of a special automatic card-printing press. The shipment of the latter had been unavoidably delayed, and the wiring of the building for electric current had not been completed. These deficiencies were supplied, however, in the course of a few weeks, and the exhibit was turned over to Mr. E. H. Bowie, in charge of the station at St. Louis, on May 21.

TELEGRAPH SERVICE.

TELEGRAPHIC REPORTS.

To meet as far as possible the pressing demands for a wider distribution of the daily telegraphic reports of observations, arrangements were perfected at the close of the year for a very generous increase in the number of such reports telegraphed over circuits or as special messages, to go into effect on July 1, 1904; including the establishment of a new circuit between Fort Worth, Tex., and St. Louis, Mo., with intermediate stations at Oklahoma, Okla., Wichita and Kansas City, Kans., and Hannibal, Mo. While for economic reasons it is impracticable to satisfy all demands in this respect, it is believed

that the present distribution of reports, resulting in a much more comprehensive display of weather conditions on the maps and bulletins issued at stations, will give general satisfaction, both to the public and to the officials charged with making district or local forecasts.

The services rendered by the principal telegraph companies in collecting and distributing the reports of observations and in telegraphing the daily forecast messages from the several district centers were, as a rule, prompt and efficient. Complaints of delays, errors, and other irregularities, when brought to the notice of the proper telegraph officials, received prompt attention and corrective action.

TELEGRAPH AND TELEPHONE LINES.

A new 3-conductor submarine telegraph cable was laid from the mainland to Block Island, R. I., a distance of 11 miles, on September 3, 1903. Preparations are now under way for laying submarine cables from near Nags Head to Manteo (Roanoke Island), N. C., from South Manitou to North Manitou Island, Lake Michigan, and from Flavel, Oreg., across the mouth of the Columbia River, to Fort Canby, Wash. All of these, it is expected, will be in operation within the next few months.

No old lines were abandoned or new ones built during the year.

The total receipts from commercial telegrams sent over Weather Bureau lines were $4,669.35, of which amount $2,337.33 was for United States tolls and was covered into the Treasury, and $2,332.02 was paid over to connecting commercial lines.

VESSEL REPORTS.

The reorganization, at the beginning of the year, of the vessel and wreck reporting service of the Weather Bureau, with additional stations at Sand Key, Fla., and Southeast Farallon, Cal., has largely added to the effectiveness of this popular feature of the Bureau, and has been much appreciated by maritime interests generally. Vessel and wreck reports are now furnished free of all charges, except for telegraph tolls over commercial lines, to all corporations and individuals who may apply for them. The average number of vessels reported per month from each designated station was as follows: Cape Henry, Va., 1,000; Jupiter, Fla., 57; Sand Key, Fla., 87; Point Reyes Light, Cal., 80; Southeast Farallon, Cal., 25; North Head, Wash., 112, and Tatoosh Island, Wash., 264.

Besides reporting passing vessels, these stations rendered important services in connection with wrecks and other maritime disasters. A brief account of the more striking cases follows:

On October 28, 1903, the schooner *Wempe Bros.* was wrecked on Bonilla Point, Vancouver Island. The Weather Bureau observer at Tatoosh Island telegraphed for assistance, which arrived in time to save the crew, but the vessel proved a total loss.

The U. S. torpedo boat *Moccasin* went ashore near Currituck Inlet, North Carolina, December 3, 1903. The Weather Bureau repairman at that point immediately opened a wreck station on the beach and put himself in direct telegraphic communication with the commandant's office at the Norfolk Navy-Yard, to convey all information and instructions to and from the scene of the wreck. Special acknowledgment was made by the Navy Department of the valuable services rendered in this connection.

On February 22, 1904, the schooner *Frank W. Howe* was observed by the North Head, Washington, station to be flying signals of distress. The observer promptly responded with an encouraging message by flag signals, and notified the life-saving crew, who succeeded in saving 7 of the vessel's crew out of 9. Vessel and cargo proved a total loss. Six days later distress signals were flown by the steam schooner *Grace Dollar*, when the same observer telegraphed for a tug, which was able to save both vessel and crew. The following is quoted from the Oregon Journal, of Portland, Oreg., in this connection:

> Sailors plying up and down the coast have a true friend in Observer Kelliher, of the North Head weather station. During the past two weeks his "eternal vigilance" has been the means of saving a score or more of them from going down to watery graves. He was the first landsman to notice the helpless condition of the American schooner *Frank W. Howe*, and with admirable alacrity communicated the intelligence to the several life-saving stations, which immediately responded to the call. With the spirit of the true hero, at the risk of his own life and health, he joined in the work of rescue. Every man on board the doomed vessel was brought ashore in safety. A few days later the watchful observer discerned a small speck out upon the misty sea that did not look altogether right. With the aid of a telescope he discovered that it was a steamer in distress. He apprised the tugboat captains and they went to the rescue. Later they returned with the *Grace Dollar* in tow, and the alert Kelliher was again the direct means of saving life and property.

On June 6, 1904, the waterlogged schooner *Antelope* was sighted by the Southeast Farallon observer in great peril. Assistance from San Francisco was telegraphed for and arrived in the nick of time to save both vessel and crew.

PRINTING AND PUBLICATIONS.

The total number of copies, consisting of the regular publications of the Bureau, together with books, bulletins, and miscellaneous pamphlets and forms, printed and disseminated during the year amounted to 46,229,853, of which 21,919,853, an increase of 1,919,853 copies over the preceding year, were printed in the office of the Bureau, as follows:

Daily Weather maps, 569,680; Monthly Weather Reviews, 57,600; Climate and Crop Bulletins, 151,567; Snow and Ice Bulletins, 31,216; station maps, 3,093,400; and miscellaneous books, pamphlets, meteoro logical charts and forms, 18,016,390.

The remainder of the work, mostly station maps and forecast cards, was performed at the Government Printing Office.

There have been no additions to or improvements in the plant since last report.

PERSONNEL OF THE BUREAU.

CLASSIFIED SERVICE.

Appointments.—During the fiscal year appointments were made as follows: By original certification at salaries ranging from $360 to $1,000 per annum, 48; by transfer at salaries from $1,000 to $1,250, 4, and by reinstatement at salaries from $360 to $1,000, 4; total, 56.

Temporary appointments.—There were 14 temporary appointments for periods from ten days to three months and at salaries from $360 to $720; 25 emergency appointments for periods from a week to thirty days and at salaries from $450 to $1,250—all of which were made under the authority of the Civil Service Commission. Total appointments, all kinds, during the year, 95.

PROMOTIONS.—One hundred and thirty-one promotions were made, all but 3 being by advancement to the next higher grade. The exceptions were: One employee promoted from $1,600 to the position of librarian and climatologist at $2,000 because he was the only one between those grades qualified for the position. One was promoted from assistant observer at $1,000 to observer at $1,300 on account of his demonstrated fitness to fill the vacancy caused by the death of a section director, he being on duty as assistant at the station at which the vacancy occurred and for months during the illness of the deceased having performed the latter's duties. The third was in the case of a messenger certified by the Civil Service Commission to fill a temporary vacancy at $450 per annum. Coincidental with the termination of the $450 vacancy another occurred in the $600 grade, to which this employee was promoted and in which he served a few days only.

REDUCTIONS.—The exigencies of the service (change of station assignment requested by employees or necessitated by the public needs) required 8 reductions. In addition, 3 were made because of carelessness in the performance of important meteorological work, 4 because of physical disability, 1 because of frequent absences without authority and delaying payment of debts, 2 because of excessive use of intoxicants and neglect of duty, and 1 because of insubordination, making a total of 19 for all causes.

RESIGNATIONS.—There were 44 voluntary separations from the Bureau, of which number 9 were permitted for the purpose of enabling employees to accept appointments in other branches of the public service. Seven resignations were required, as follows: Three for inefficiency, 1 for excessive use of drugs, 1 for inefficiency and marked personal uncleanliness, 1 for nonpayment of debts, and 1 for delaying payment of debts and tardiness in reporting for duty. Total separations, 51.

REMOVALS.—Discharges were ordered in 9 cases, for the following causes: Unsatisfactory service, 4; intoxication and neglect of duty, 1; insubordination and unsatisfactory service, 2; intoxication and insubordination, 1; untruthful statement as to cause of absence and neglect of duty, 1.

DEATHS.—The total number of deaths was 5. During the preceding year but 2 were recorded.

UNCLASSIFIED SERVICE.

Appointments to the unclassified service numbered 9 (the salaries ranging from $1.50 per diem to $600 per annum), as follows: For duty at Washington, D. C., 4 (1 through the Board of Labor Employment and 3 for temporary periods of less than one month); for duty outside the District of Columbia, 5 (of which number 4 were appointed as temporary laborers at $1.50 per diem and employed in road building in connection with the new station at Mount Weather, Va.).

Nine unclassified employees were promoted during the year, each promotion being made to the next higher grade, the salaries ranging from $480 to $720 per annum.

One unclassified employee was reduced, on account of change of station, at his own request. Eight voluntary resignations were accepted and 1, a station agent, was necessitated by a change of the status of

the station at which the agent was serving. But 2 unclassified employees were removed; one under strong suspicion of theft, and the other for obtaining leave of absence under false representation when his services were needed, and for absence without authority. No deaths occurred in the unclassified service.

ABSENCES DURING THE CALENDAR YEAR 1903.

STATION.—The average absence of station employees, with pay, during the calendar year 1903, was 1.1 days on account of sickness and 10.5 days on account of annual leave. Ninety-nine per cent of the station employees being males, the matter of sex has been disregarded in figuring the average.

WASHINGTON, D. C.—The average absence, with pay, of employees at Washington, D. C. (clerks, mechanics, messengers, and laborers), during the same period was, males, 4.7 days on account of sickness and 27.1 days on account of annual leave; females, 6.7 days on account of sickness and 28.8 days on account of annual leave.

The general average of the entire service, station and Washington combined, was 2.1 days on account of sickness and 14.9 days on account of annual leave.

STATISTICS OF THE SERVICE.

The following tables show in compact form the numerical strength of the Bureau and the highest and lowest salaries paid in the classified and unclassified grades:

Numerical strength of the Weather Bureau, July 1, 1904.

At Washington, D. C.:		
Classified	169	
Unclassified	14	
		183
Outside of Washington, D. C.:		
Classified	476	
Unclassified	11	
		487
Total commissioned employees		670
Additional employees outside of Washington, D. C.:		
River observers	230	
Storm-warning display men	236	
Cotton-region observers	141	
Corn and wheat region observers	135	
Rainfall observers	71	
Fruit and wheat region observers	19	
Sugar and rice region observers	9	
Total noncommissioned employees		841
Total paid employees		[a] 1,511
Voluntary observers		3,367
Voluntary crop correspondents		13,406
Total numerical strength		18,284

[a] This total embraces all paid employees in the Bureau on July 1, 1904, including the Chief of Bureau, but excluding employees on furlough for three months or more.

Distribution of commissioned force.

In Washington, D. C.:

Accounts Division	13	Library	3
Barometry and research work	3	Meteorological Records Division	15
Climate and Crop Division	7	Miscellaneous mechanical work	4
Editor, Monthly Weather Review	2	Publications Division	45
Executive work	19	Supplies Division	9
Forecast Division	16	Telegraph Division	11
Instrument Division	10	Under captain of the watch	26

Outside of Washington, D. C.:

66 stations with 1 employee	=	66 employees.
47 stations with 2 employees	=	94 employees.
31 stations with 3 employees	=	93 employees.
17 stations with 5 employees	=	85 employees.
14 stations with 4 employees	=	56 employees.
4 stations with 6 employees	=	24 employees.
4 stations with 7 employees	=	28 employees.
4 stations with 8 employees	=	32 employees.
1 station with 9 employees	=	9 employees.
188		487

Salaries paid in the classified and unclassified grades.

Grades.	July 1, 1904.	
	Station.	Washington, D. C.
CLASSIFIED GRADES.		
Highest salary	$3,000	$5,000
Lowest salary	360	450
Average salary	1,007	1,216
UNCLASSIFIED GRADES.		
Highest salary	720	720
Lowest salary	300	240
Average salary	541	534

Average salary for all (station and Washington, including the Chief of Bureau), $1,029.

The foregoing table of salaries does not include employees on duty at substations (storm-warning displaymen, river observers, etc.), whose compensation ranges from $5 to $20 per month, and whose tour of service would average less than one hour a day.

METEOROLOGICAL RECORDS.

The routine work of recording the date of receipt of each meteorological form, examining and correcting same, tabulating the data contained therein for publication in the Monthly Weather Review, and Annual Report of the Chief of Weather Bureau; preparing error letters for the several forms; charting data from regular and selected voluntary stations for the several charts in Weather Review, and from which to prepare text; compiling data in compliance with requests from different Federal Departments and bureaus, including different divisions of the Weather Bureau; for State, county, and city officials; civil engineers, lawyers, physicians, health and pleasure seekers, numerous commercial concerns and purposes, and for certification under the seal of the Department has continued throughout the year.

INFORMATION SUPPLIED THE PUBLIC.

During the year 887 requests for data were answered, occupying in their preparation from a few minutes to days—sometimes as many as five to twelve. Besides this there were 90 calls for certified data, requiring 257 sheets, this not including a request from the sanitary district of Chicago, which required about one thousand hours to compile and verify the data, the work being performed by persons not connected with the Weather Bureau, and paid for by the sanitary commission.

Owing to the limited clerical force and the demands upon the time of clerks for more important duties, it was found necessary to adopt a new policy in connection with requests for certified data, viz: When there was a Weather Bureau office in the city in which applicant resided and the data were desired for that place the request was complied with, and in the letter of transmittal it was suggested to the applicant that he arrange to have future needs for such data filled by process of subpœna duces tecum served upon the official in charge of the station.

For requests for data which did not require certification from persons residing in a place where there is a Weather Bureau station, the applicants were referred to the local office and informed that they would be granted access to the records and allowed to extract the desired data. During the last few months applicants for information contained in climate and crop publications were referred to the local section directors.

IMPROVEMENTS IN SERVICE.

A scale for determining, without computation, wind velocities from the triple register sheets, devised and used by Mr. Arthur Thompson for several years past, was adopted as the standard gauge for station use and the necessary drawings made from which to have plates engraved for the purpose of printing the scales and issuing them to all stations.

All instructions for the preparation of meteorological forms, which heretofore have appeared on the backs and covers of the several forms, and in various other places, were revised and assembled in one publication under the caption, "Instructions for preparing meteorological forms, division of meteorological records circular, 1904." In this circular has been brought together all instructions for preparing meteorological forms, which will do away with the printing of instructions on the several forms, be a great convenience to observers, and render unnecessary the destruction of editions of forms which have become obsolete because of amendments to instructions relative thereto and the issue of new editions of the forms, thereby saving the expense of printing new editions. The circular will be issued each year, amended to date so far as practicable.

Under the supervision of the official in charge of the division, Mr. Eric Miller codified, and practically rewrote, the Instructions to Observers, in future to be known as "Station Regulations."

Negotiations are under way to obtain a large number of charts of the very best procurable types of clouds, with a view of having them mounted in a neat and attractive manner for issue to stations and for

sale to teachers of meteorology and physical geography and others. It is believed they will meet a popular want and their sale be large.

RECOMMENDATIONS CONCERNING APPROPRIATIONS FOR 1905.

It is recommended that the appropriations for the fiscal year beginning July 1, 1905, be the same as those for the current fiscal year, with the following exceptions:

An increase of $1,000 per annum, from $2,000 to $3,000 per annum, in the salary of the chief of the Climate and Crop Division, is urgently recommended. This official has charge of the climate and crop service of the Bureau. He writes the weekly National Crop Report, and supervises the reports issued by State section directors. For many years his work has been of such a high order, and has so commended itself to the agricultural and commercial industries of the country as to reflect credit upon the public service. In order that these reports, which frequently influence the price of the products of the farm, may command the confidence of the public, it is essential that there be assigned to the work an official whose integrity, as well as whose ability, is so high as to be above suspicion. The present incumbent has made no request for advancement, but I am firmly of the opinion that it would be a wise economy, as well as a just action, to recognize his many years of valuable and faithful public service by making the increase in salary herein recommended.

It is also recommended that the salary of the assistant chief of the Division of Accounts of the Department of Agriculture, who is appropriated for in another part of the bill making appropriations for the support of the Department of Agriculture, and who serves under the joint direction of the Disbursing Officer of the Department and the Chief of the Weather Bureau, as disbursing clerk of the Bureau, be increased from $2,000 to $2,500 per annum. For nearly ten years I have had the benefit of the valuable assistance of this official in handling the fiscal affairs of the Bureau. I have implicit confidence in his integrity, and know that his ability as an accountant is of the highest order. If the committee in Congress would look into the manner in which his many and important duties are performed, I believe that they would agree with me that his long and faithful service should be rewarded by the advancement in his salary that is now recommended. The Disbursing Officer of the Department joins me in this recommendation. There is no part of the work of the Weather Bureau that requires higher executive and business ability than that performed by this officer.

An increase of $20,000, as submitted under "Salaries outside of the city of Washington," is to cover the salaries of officials and employees required to establish eight new stations.

An increase of $2,000, as submitted under "Fuel, lights, and repairs," is for the purchase of new boilers for heat, light, and power.

An increase of $20,000, as submitted under "General expenses," is for supplies and maintenance of eight new stations.

An increase of $52,000 (from $48,000 to $100,000), as submitted under "Buildings, Weather Bureau," is for the purpose of erecting not less than ten Weather Bureau observatory buildings. The present

appropriation provides for the erection of not less than five buildings, which number has not met the growing demands for the construction of new observatories. The wisdom of the Department in erecting and owning its own observatories is more manifest each day. It not only saves the amount now paid for rent of office quarters, but provides structures with roof exposures suitable to meteorological purposes, and also adds dignity to the public service.

An increase of $8,000 (from $27,000 to $35,000), as submitted under "Cables and land lines," is for the purpose of constructing cables and land lines to connect Beaver Island with Charlevoix, Mich., or some point in the immediate vicinity.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 8, 1904.

Sir: I have the honor to submit herewith a report of the operations of this Bureau for the fiscal year ended June 30, 1904.

Respectfully,

D. E. Salmon, *Chief.*

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR.

CONTROL OF CONTAGIOUS DISEASES.

SCAB OF SHEEP, CATTLE, AND HORSES.

It became evident last year that the means which the Bureau had employed up to that time to stamp out sheep scab were not proving as effectual as desired. This condition was due to various drawbacks. During the year just closed the methods of work were not changed in essential particulars, but the force of inspectors was increased, and wherever possible their work was concentrated until the scab was cleaned up from that point.

Last year the legislature of Wyoming, realizing that the sheep industry of that State could not prosper until the scab was eradicated, enacted a law providing for the cooperation of the board of sheep commissioners with this Bureau. Each of the inspectors of the Bureau in Wyoming received the additional appointment of inspector for the State. The result is stated by the board of sheep commissioners as follows:

> All sheep in the scab-infected counties were treated, and early in the spring of the present year the effects of the general dipping in 1903 were apparent, fully 75 per cent of the bands treated for the disease having been cleaned up. This season it was decided to continue the dipping, and we are pleased to note that the sheep men of the State, with few exceptions, are complying with the orders of the board.
>
> Last fall the counties of Albany, Laramie, Converse, and Weston were declared clean, and shipments went forth from those counties unrestricted. This year it is believed other counties will be declared clean, and in a short time Wyoming will be stricken from the list of scab-infested States.

It can be stated, some months since the above was written, that the final work will soon be done in Wyoming and the Bureau's force of inspectors will be employed elsewhere.

The total number of inspections of sheep for scabies during the fiscal year was 40,967,961; the total number of dippings was 9,578,476, of

which 1,957,278 were redippings. The number of cars cleaned and disinfected under the supervision of employees of the Bureau on account of this disease was 2,732.

The total number of inspections of cattle for scabies during the fiscal year was 1,124,321; the total number of dippings was 157,757, of which 59,788 were redippings. The number of cars cleaned and disinfected on account of this disease, under the supervision of employees of the Bureau, was 532.

The number of horses inspected from January 1 to June 30, 1904, was 752, of which 453 were found to be scabby; 138 infected were dipped in lime and sulphur. Three cars which had contained scabby horses were cleaned and disinfected.

VENEREAL DISEASE OF HORSES.

Work for stamping out a venereal disease of horses, the so-called maladie du coït, has been carried on since its inauguration under the immediate supervision of the Quarantine Division. In reporting upon it for the previous fiscal year some of the obstacles to the ready eradication of the disease were referred to. Among these obstacles have been the wild state of most of the country over which the disease has spread, the unbroken condition of the animals, and the lack of cooperation and aid on the part of owners throughout the worst infected sections, these being in and adjacent to the Indian reservations of South Dakota. Nevertheless, owing to the vigorous manner in which the work was prosecuted and the success then already attained, the hope was expressed that this disease might at a not very remote period be entirely stamped out. It is gratifying to be able to state that the hope then expressed has been so far realized that in the great annual round-up which lasted this year from June 1 to 28, inclusive, not a single diseased animal nor a suspect was found.

During the year 76 animals were slaughtered because of showing evidences of the disease—4 stallions and 72 mares. In addition, 1,103 stallions which were running at large were castrated, and 302 stallions to be used for breeding purposes were tagged for identification. The total number of animals inspected was 11,604. The average indemnity paid by the Department for the 76 animals slaughtered because of being diseased was $21.21; the total amount was $1,612.

At the close of the year the services of laborers, who had been regularly employed in riding the range for the purpose of locating diseased animals, in performing castrations, and in doing other necessary work under the direction of the inspector in charge, were dispensed with; and under date of June 28, 1904, the Secretary of Agriculture issued an order, known as Bureau of Animal Industry Order No. 126, the subject-matter of which was regulations to prevent the spread of maladie du coït of horses. The provisions of this order, so far as they related to the work in the Indian reservations, were previously concurred in by the Secretary of the Interior.

Investigation regarding the nature and cause of this venereal disease has been continued during the past year. Additional opportunity for its study was afforded by an outbreak in eastern Iowa similar to those in Nebraska and South Dakota, and from which point an affected stallion and mare were brought from Iowa to the experiment station of this Bureau for further examination. In order to make a compara-

tive study of this disease as it occurs in the United States, and of maladie du coït, or dourine, as it occurs in France, arrangements were made through the courtesy of the late Professor Nocard for an official of this Bureau to make a study of dourine and its trypanosoma at the National Veterinary School at Alfort, France. This work was assigned to Dr. John R. Mohler, chief of the Pathological Division. Every opportunity was afforded him for the study of material at this school, and through the kindness of Doctor Nocard's assistants, Doctor Vallée and Doctor Carré, a dog was inoculated with the protozoan *Trypanosoma equiperdum*, from a horse affected with dourine, and brought to this country for the purpose of making a more detailed study of this parasite and the disease it engenders in horses.

MEAT INSPECTION.

During the fiscal year 1904 the inspection of cattle, sheep, calves, and hogs, and their products was conducted at 152 establishments, located in 51 cities. Inspection was inaugurated at 5 establishments, 3 of which were in cities where it was already in operation in other establishments, and 2 in other places. Inspection was discontinued at 12 establishments in 8 cities where it had been in operation the preceding year. The inspection of horses for slaughter ceased during the year 1903 and was not resumed in 1904.

The following summary shows the number of establishments and the number of cities at which inspection was conducted during each fiscal year since 1891:

Establishments and cities where meat inspection was conducted, 1891 to 1904.

Fiscal year.	Number of establishments.	Number of cities.	Fiscal year.	Number of establishments.	Number of cities.
1891	9	6	1898	135	35
1892	23	12	1899	139	42
1893	37	16	1900	149	46
1894	46	17	1901	157	52
1895	55	19	1902	155	50
1896	102	26	1903	156	50
1897	128	33	1904	152	51

The number of inspections of live animals for slaughter and the number rejected on such examination are shown in the following table:

Antemortem inspections for the fiscal year 1904.

Kind of animal.	For official abattoirs in cities where inspections were made.	For abattoirs in other cities and miscellaneous buyers.	Total inspections.	Rejected (subject to result of postmortem inspection).	
				At abattoirs.	In stock yards.
Cattle	6,490,144	6,109,687	12,599,831	757	42,263
Sheep	8,106,716	6,526,413	14,633,129	1,230	12,442
Calves	703,507	440,455	1,143,962	500	6,555
Hogs	24,722,894	11,513,567	36,236,461	3,807	59,519
Total	40,023,261	24,590,122	64,613,383	6,294	120,779

The preceding statement, when compared with the similar statement for 1903, shows an increase of more than 8 per cent in the total number of animals inspected for official abattoirs. This increase applies to all classes of animals except sheep, the number of which decreased about 3½ per cent, while the number of hogs inspected antemortem for official abattoirs increased about 14 per cent, the number in 1903 having been 21,707,381, as against 24,722,894 in 1904.

Following is shown the number of postmortem inspections and the number of carcasses and parts condemned (exclusive of hog carcasses condemned for trichinæ):

Postmortem inspections for the fiscal year 1904.

Kind of animal.	Number of inspections.			Carcasses condemned.			
	For official abattoirs.	On animals rejected in stock yards.	Total.	For official abattoirs.	Animals rejected in stock yards.	Total.	Parts of carcasses condemned.
Cattle	6,350,011	33,069	6,383,080	12,354	3,791	16,145	5,307
Sheep	8,261,051	8,082	8,269,133	7,151	1,263	8,414	341
Calves	764,590	3,337	767,927	1,207	922	2,129	114
Hogs	24,128,462	41,768	24,170,230	57,516	4,971	62,487	126,840
Total	39,504,114	86,256	39,590,370	78,228	10,947	89,175	132,602

Here, as in the antemortem inspections, the increase over 1903 is general, except as to sheep, being, however, principally in hogs, the number increasing from 21,827,047 in 1903 to 24,170,230 in 1904.

In addition to the number of carcasses condemned for various causes on the regular postmortem inspection and for trichinæ on the microscopic inspection, the numbers shown below were tanked for other reasons, as designated in the statement.

Animals lost otherwise than by disease.

Manner of death.	Cattle.	Sheep.	Calves.	Hogs.	Total.
Died in yards	727	888	106	1,152	2,873
Killed in yards	1,682	1,064	1,285	13,248	17,279
Died in abattoirs	543	1,978	279	14,663	17,463
Total	2,952	3,930	1,670	29,063	37,615

The following table shows in detail the various diseases and conditions for which carcasses and parts were condemned and tanked during the year, and also includes those found dead and those killed by city inspectors:

Causes of condemnation of carcasses and parts of carcasses, fiscal year 1904.

Cause of condemnation.	Cattle.		Sheep.		Calves.		Hogs.	
	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.
Actinomycosis	1,130	2,379			16		55	46
Tuberculosis	10,173	703	11		22		34,656	118,820
Caseous lymphadenitis			1,593	66				
Cholera and swine plague							17,089	
Texas fever	71				58			
Echinococcus			1				3	8
Measles							10	
Scabies			18				82	
Eczema							9	
Erysipelas							6	
Cancer	68		7		1		15	
Tumor	12	2	4			1	538	290
Abscess	71	709	83	17	10	15	740	853
Pneumonia	201		362	1	26		1,137	
Pleurisy	3		19	11	4		115	12
Carditis			2					
Enteritis	32		132		18		271	
Peritonitis	222		88		38		551	
Metritis	25		16				175	
Nephritis	11		45		5		52	
Uremia	4		31		8		21	
Mammitis			1					59
Septicemia	255		175		48		677	
Pyemia	392		200		49		2,594	
Gangrene	35		10	4	8	16	31	
Anemia, emaciation, marasmus	1,870		3,833		356		611	
Ascites	13		58		1		45	
Jaundice	8		647		15		926	
Extreme temperature, various causes			42		1		1,550	
Pregnancy	90		63				171	
Recent parturition	66		13				42	
Hernia			4				9	
Downers, bruised, injured, etc	1,381	1,514	905	157	176	82	306	6,752
Dead from various causes	1,270		2,866		385		15,815	
Too young					1,258			
Killed by city inspectors	1,682		1,064		1,285		13,248	
Arthritis			1		4			
Tapeworm			1					
Pulmonary apoplexy			42		3			
Improper bleeding			1					
Flukes, hydatids, etc			1	85				
Distoma			2					
Edema			2		1			
Melanosis			1		3			
Asphyxia	12							
Total	19,097	5,307	12,344	341	3,799	114	91,550	126,840

The following comparative statement of postmortem inspections for official abattoirs from 1891 to 1904 shows that this work the past year was greater than in any previous year in the history of the Bureau:

Comparative statement of animals inspected at slaughter for abattoirs having inspection, fiscal years 1891 to 1904.

Fiscal year.	Cattle.	Calves.	Sheep.	Hogs.	Horses.	Total.
1891	83,889					83,889
1892	3,167,009	59,089	583,361			3,809,459
1893	3,922,079	92,947	870,512			4,885,538
1894	3,861,594	96,331	1,020,764	7,648,146		12,626,835
1895	3,704,042	116,093	1,428,601	13,616,539		18,865,275
1896	3,985,484	256,905	4,629,796	14,250,191		23,122,376
1897	4,242,216	273,124	5,209,161	16,808,771		26,533,272
1898	4,418,738	244,330	5,496,904	20,893,199		31,053,171
1899	4,382,020	246,184	5,603,096	23,836,943	3,332	34,071,575
1900	4,841,166	315,693	6,119,886	23,336,884	5,559	34,619,188
1901	5,219,149	413,830	6,639,212	24,642,753	1,992	36,916,936
1902	5,559,969	555,836	7,434,878	25,277,107	1,649	38,829,439
1903	6,134,410	668,855	8,585,960	21,793,738	344	37,183,307
1904	6,350,011	764,590	8,261,051	24,128,462		39,504,114

The meat-inspection tag or label was placed upon 22,943,067 quarters and 120,404 pieces of beef, 8,230,528 carcasses of sheep, 765,301 carcasses of calves, 1,122,193 carcasses of hogs, and 726,779 sacks of pork.

Following is shown the number of meat-inspection stamps that were affixed to packages of meat and meat products that had received the regular postmortem inspection:

Meat-inspection stamps.

Kind of meat.	Packages stamped (white stamps).
Beef	7,[illegible]7,762
Mutton	42,596
Veal	165
Pork	15,524,234
Total	23,054,757

The number of cars sealed, containing inspected meat and meat products for shipment to official abattoirs and other places, was 80,551.

INSPECTION OF EXPORT MEATS.

There were 37,151 certificates of ordinary inspection issued to cover meat and meat products for export, as follows: 1,530,474 quarters, 14,544 pieces, 3 carcasses, and 1,479,833 packages of beef, weighing 419,058,781 pounds; 2,131 carcasses, and 19,975 packages of mutton, weighing 712,089 pounds; 42,765 carcasses and 515,304 packages of pork, weighing 154,442,440 pounds; a grand total of 574,213,314 pounds.

Compared with the figures for 1903 this shows an increase in beef exports of 47,138,044 pounds, a decrease in mutton exports of 2,016,924 pounds, and an increase in pork exports of 21,319,830 pounds, being a net increase of 66,440,950 pounds.

The comparatively large decrease in the exports of mutton is explained by the fact that during a few previous years, on account of severe drought in Australia and New Zealand, the shipments of mutton from those countries to Europe were greatly reduced, so that there was an unusual demand for mutton from this country. The conditions last year having become normal, the trade in this class of product has decreased to its normal proportions.

Following is a comparative statement of beef, mutton, and pork exported under certificates of ordinary inspection during the past seven years:

Comparative statement showing quantities of meat for export under certificates of ordinary inspection, 1898 to 1904.

Fiscal year.	Beef.	Mutton.	Pork.
	Pounds.	*Pounds.*	*Pounds.*
1898	339,650,091	324,996	244,956,482
1899	360,843,856	525,705	278,696,435
1900	438,138,233	680,897	272,050,663
1901	452,830,373	894,648	231,144,938
1902	416,990,762	1,145,248	188,360,011
1903	371,920,737	2,729,013	133,122,610
1904	419,058,781	712,089	154,442,440

The cost of the work of ordinary inspection (interstate trade as well as exports) for the year was $781,590.95.

MICROSCOPIC INSPECTION OF PORK.

The total number of carcasses examined for trichinæ was 315,045, classified as follows: Class A (free from all appearances of trichinæ), 307,621, being 97.64 per cent; Class B (containing trichinæ-like bodies or disintegrating trichinæ), 4,773, being 1.52 per cent; Class C (containing live trichinæ), 2,651, being 0.84 per cent.

The number of certificates issued for microscopically inspected pork was 1,576; the number of packages stamped for export was 30,734, weighing 9,020,521 pounds, being a decrease from the previous year of 10,087,820 pounds. This very large decrease is due to the falling off of our trade with Germany, the latter being our chief customer among the countries requiring microscopic inspection. The new German fiscal regulations operated against our trade in the past year to the extent that our shipments fell, in approximate figures, from 15,000,000 pounds in 1903 to 5,000,000 pounds in 1904.

The number of trichinous carcasses disposed of was 2,643; these weighed 612,912 pounds; 38.5 per cent of this amount was tanked, and 61.5 per cent was made into cooked meat products.

Following is a comparative statement of the quantity of pork exported to countries requiring certificates of microscopic inspection, 1892 to 1904.

Exports of pork inspected with microscope.

Fiscal year.	Weight.	Fiscal year.	Weight.
	Pounds.		*Pounds.*
1892	22,025,698	1899	108,858,149
1893	8,059,758	1900	55,809,626
1894	18,845,119	1901	35,942,404
1895	39,355,230	1902	33,681,229
1896	21,497,321	1903	19,108,341
1897	42,570,572	1904	9,020,521
1898	120,110,356		

The cost of microscopic inspection for the year was $53,934.01, being an average of 17.1 cents for each carcass examined and 0.6 cent for each pound exported.

INSPECTION OF VESSELS AND EXPORT ANIMALS.

The number of clearances of vessels carrying live stock was 774. The number of certificates of inspection issued for American cattle exported to Europe was 1,419.

Following is a statement of the number of American and Canadian animals inspected for export, the number exported, etc. As compared with similar figures for 1903 this statement shows an increase of 43.7 per cent in the number of American cattle exported, and an increase of 116.5 per cent in the number of American sheep exported; while the number of American horses exported in 1904 is shown to be nearly one-third less than the number exported in 1903.

Number of inspections, etc., of American and Canadian animals for export, fiscal year 1904.

Kind of animal.	American.				Canadian.		
	Number of inspections.	Number rejected.	Number tagged.	Number exported.	Number inspected.	Number rejected.	Number exported.
Cattle	764,126	3,157	424,689	[a]414,320	26,370	8	26,362
Sheep	474,754	460	.....	[b]241,294	60,096	47	60,049
Horses	3,258	2	2,724	2,649	35	.....	35

[a] 47,653 via Canada. [b] 12,699 via Canada.

All the animals included in the above statement were exported to Great Britain, except 18,439 cattle, 11,135 sheep, and 111 horses to Belgium; 399 cattle, 137 sheep, and 1 horse to South Africa; 198 horses to Germany, and 4 horses to Italy.

In addition to the exports mentioned above there were also exported to other countries 1,749 cattle, 2,335 sheep, 10 horses, 20 swine, and 1 jackass, making a total of 4,115, destined as follows: 1,520 cattle, 2,036 sheep, and 10 horses to Bermuda; 298 sheep to Barbados; 203 cattle and 1 sheep to Brazil; 22 cattle, 20 swine, and 1 jackass to Argentina; 4 cattle to Mexico.

The number of American and Canadian animals landed alive and inspected by representatives of this Bureau, at London, Liverpool, and Glasgow, is shown in the statement below. The apparent discrepancy between this statement and the preceding statement showing the number exported is accounted for by the number of animals exported to countries other than Great Britain, and to such British ports as Hull, Bristol, and Manchester, where the Bureau has no representative:

Statement showing number of animals inspected at time of landing in London, Liverpool, and Glasgow, and loss in transit, fiscal year 1904.

From—	Cattle.			Sheep.			Horses.		
	Landed.	Lost.	Per cent of loss.	Landed.	Lost.	Per cent of loss.	Landed.	Lost.	Per cent of loss.
United States	360,990	610	0.17	212,299	2,011	0.94	2,353	13	0.55
Canada	19,375	39	.20	57,767	1,555	2.62	35	.....	.....
Total	380,365	649	.17	270,066	3,566	1.30	2,388	13	.54

INSPECTION OF IMPORTED ANIMALS.

Animals were inspected for importation from Mexico, as shown below:

Statement showing importation of Mexican animals, fiscal year 1904.

Port of entry.	Cattle.	Sheep.	Swine.	Goats.	Horses.	Mules.	Asses.	Burros.	Dromedary.
Eagle Pass, Tex	.....	.....	.....	.....	6	.....	.....	.....	.....
El Paso, Tex	7,603	.....	.....	.....	5	15	.....	.....	.....
Nogales, Ariz	3,645	.....	15	13	140	65	7	.....	.....
San Diego, Cal	840	700	66	.....	154	15	2	3	.....
Laredo, Tex	.....	1	.....	.....	9	.....	1	.....	1
Total	12,088	701	81	13	314	95	10	3	1

Inspections were also made at El Paso of animals imported from Mexico, in bond, as follows: 1,201 sheep in transit to Mexico; 9,461 cattle, 103 horses, and 7 mules in transit to Canada.

QUARANTINE AT PORTS OF ENTRY.

Heretofore there have been frequent arrivals at seaboard ports of animals of the ruminant class, and occasionally of swine, destined for menageries and parks, for which no permit had been obtained previous to shipment, although such a permit is required by paragraph 9 of Order No. 109 of this Bureau, being regulations concerning the inspection and quarantine of horses, neat cattle, sheep, and other ruminants, and swine imported into the United States. Recent instructions have been given to United States consuls, however, by the Secretary of State, which have removed all misunderstanding as to the meaning of the term "ruminants." All hay-eating animals are not ruminants, but such only as regurgitate a portion of their food for remastication, or, as it is commonly stated, "chew the cud." Asses, mules, zebras, and zebrules are admitted under the provisions of the regulations governing the importation of horses, and ruminants other than cattle and sheep, as provided for sheep.

IMPORTS OF PUREBRED DOMESTIC ANIMALS, ETC.

The importation of purebred cattle, sheep, and hogs during the year has been extremely light. There have been received at New York, the chief port of entry for animals for breeding purposes, in the classes named, and quarantined at the animal quarantine station for that port, located at Athenia, N. J., 266 cattle, 128 sheep, and 123 hogs. At the other ports on the Atlantic seaboard designated as ports of entry for import animals requiring inspection and quarantine, animals were entered as follows: At Boston, and quarantined at the animal quarantine station at Littleton, Mass., 17 cattle, 15 sheep, and 3 hogs; at Baltimore, and quarantined at the quarantine station at Halethorp, Md., 48 cattle, 2 sheep. While the importations of cattle and sheep, as well as hogs, have been light, there has been an unusual number of entries of other ruminants, such as are imported by owners of menageries and zoological collections, all of which are subject to inspection and quarantine.

IMPORTATIONS NOT SUBJECT TO QUARANTINE.

There have been imported through ports on the seacoast animals not subject to quarantine as follows:

Numbers of animals imported not subject to quarantine.

Country.	Horses.	Ponies.	Mules.	Asses.
Great Britain	1,523	3	1	2
Germany	204			6
Belgium	651			10
Italy	6			16
Egypt				15
Mexico	3	8	1	
Porto Rico	4	1		
Costa Rica	2			
Argentina	1			
Bermuda	10	1		1
Cuba	5			
Canada	16			
Iceland		2		
Total	2,425	15	2	50

QUARANTINE AGAINST HOLLAND WITHDRAWN.

It having been shown that Netherlands was free from contagious foot-and-mouth disease and other contagious and infectious diseases of animals, for the existence of which this Department prohibited their importation, the embargo was withdrawn from Holland cattle by the order of the Secretary under date of February 24, 1904, in Amendment No. 2 to Order No. 109, of the Bureau of Animal Industry.

FOOT-ROT OF SHEEP.

Considerable difficulty was experienced in securing suitable material for the continuation of investigations as to the cause of foot-rot of sheep; but an outbreak among a flock in West Virginia and the arrival at the Buffalo stock yards of a flock from the West, 75 per cent of which were lame, furnished the desired subjects. From these sheep the constant presence of the *Bacillus necrophorus* in all of the affected feet was fully established.

This microorganism has been previously recognized as the causative agent in the development of ulcerous, necrotic lesions in several diseases of domestic animals, and tests made with it upon the feet of healthy sheep have shown that it is capable, when applied in pure culture, of producing lesions which closely resemble those found in cases of foot-rot resulting from natural infection. The tests have also shown that its use, in association with the other microorganisms present in affected feet, will produce the disease in its typical form; while the use of these same associate bacteria without the presence of the *Bacillus necrophorus* will produce no lesion upon the healthy foot. Basing deductions upon the above facts, it seems reasonable to conclude that the *B. necrophorus* must be present before a true case of foot-rot can develop in sheep. A bulletin, emanating from the Pathological Division, treating of the nature, cause, and treatment of this disease, is now in the hands of the printer.

PRESENCE OF GID OF SHEEP IN THE UNITED STATES.

During a recent trip to Montana by the acting zoologist of this Bureau, specimens of a bladderworm were obtained from the brain of a sheep which seems to be identical with the gid bladderworm, *Cœnurus cerebralis*, of Europe, and it produced similar symptoms. This bladderworm, the adult stage of which (*Tænia cœnurus*) lives in the intestines of dogs, is very common in the Old World, and is one of the most dangerous and destructive parasites with which sheep may be infected. A few years ago it was said that 1,000,000 sheep die from it annually in France, and the losses in Germany have been put at 15 per 1,000 in the first year of life, 5 in the second year, 2 in the third year, and 1 in the fourth. In England, although the parasite seems to be less common than formerly, the mortality at times in some flocks is as high as 35 per cent. The only practicable treatment lies in prevention, which consists principally in keeping the dogs free from tapeworms by frequent dosing with vermifuges and by preventing them from eating the uncooked brain or spinal cord of infected sheep. Until the present time no well-established cases have been reported from the United States, which is rather remarkable in the face of numer-

ous importations from Europe both of sheep and dogs, some of which must certainly have been infected. Although the conditions existing in this country are perhaps unfavorable to the parasite, so that it has been unable to gain a foothold, and although so far it may have caused little damage, its presence here is, nevertheless, a constant menace; and there is danger that, if unchecked, it will in the future become as serious a pest in the United States as it is in Europe. It is therefore important that a careful investigation of this parasite be made in this country, and that thorough measures be taken to prevent its dissemination.

TUBERCULOSIS.

The work on the subject of tuberculosis is being conducted in two divisions of the Bureau. In the Pathological Division the comparative study of tubercle bacilli which were obtained from a number of varied sources has been in constant progress during the entire year, having been continued under the same conditions as those inaugurated at the commencement of this investigation.

Additional cultures have been obtained from a tuberculous parrot and from a raccoon, the disease in each case being the result of natural infection. In addition to these, tuberculous specimens have been received which were taken from a snake, a monkey, a Philippine deer, and from a number of hogs and cattle. While bacilli from none of these latter have been grown artificially, the specimens have been used to demonstrate the form of bacillus present in each case, its manner of grouping, and the character of lesion produced by it in its natural host. Experiments have been made with two cultures of slight virulence for the purpose of determining the conditions under which an added degree of virulence may be given them. These investigations are about concluded and the results are now in course of preparation for publication.

In the Biochemic Division the experiments concerning the intercommunicability of human and bovine tuberculosis have been completed, and Part I of Bulletin No. 52, entitled "The Virulence of Human and Bovine Tubercle Bacilli for Guinea Pigs and Rabbits," has been published. Parts II and III of this bulletin are now in manuscript form and are about ready for the printer. Considerable delay in the publication of the last two parts of this bulletin has been caused by the death of Dr. E. A. de Schweinitz, the former chief of this division.

The results of our experiments concerning the infectiousness of human tuberculosis for cattle, and also those experiments concerning the comparative virulence of human and bovine tubercle bacilli for other animals, may be briefly summarized as follows: Nine fresh cultures of tuberculosis from as many different cases of that disease in human beings were isolated; four of these cultures were isolated from children affected with generalized tuberculosis. None of the cultures isolated from adults exhibited a degree of pathogenic power for cattle which was in any way comparable to that usually manifested by the bovine tubercle bacillus. Of the four cultures isolated from children, however, two produced a generalized tuberculosis in calves after subcutaneous inoculation, and the lesions produced were quite as severe as those produced by a fresh culture of the bovine tubercle bacillus which was isolated from a case of natural tuberculosis in a cow. A third one

of the cultures from children, while distinctly less virulent than the two just mentioned, was able to bring about a localized infection, which spread from the point of inoculation to several of the neighboring lymph glands. This third culture should be considered pathogenic for cattle, though in a distinctly less degree than the ordinary bovine bacillus.

The inoculation experiments with hogs and rabbits gave results quite similar to those obtained with cattle, two of the human cultures (from children) being indistinguishable from the bovine bacillus in respect of their action upon these animals. The inoculation of guinea pigs brought out no distinctions that were worthy of note between the various cultures.

These experiments, it is believed, go to show conclusively that it is an error to conclude that cattle can not be infected with human tuberculosis; and they also indicate that the children from which the two most virulent cultures were obtained were either infected from bovine sources or that certain forms of human tubercle bacilli are indistinguishable from bovine bacilli, both with regard to their virulence and cultural characteristics; furthermore, they agree in general with those of the great majority of investigators who have studied this subject during the past two years. These experiments not only justify but show the desirability of a rigid enforcement of public regulations looking to the control and the eradication of tuberculosis in cattle.

At the experiment station of the Bureau certain features of investigations in tuberculosis are carried on. Cow No. 218, to which reference was made in my last report, is still there. This cow received an injection of human tubercle culture into one quarter of the udder over two years ago. The injection was made so as to prevent any injury to the tissues other than such as would result from the presence of the infected germs. The material secreted by the injected quarter of the udder continues to show the presence of the tubercle germs, and is infectious for guinea pigs on subcutaneous injection. The cow has lately dropped a calf, and it will be interesting to observe whether the latter contracts the disease.

THE DISTRIBUTION OF TUBERCULIN.

During the past year there were prepared in the biochemic laboratory and sent to the various States and Territories and foreign countries enumerated below about 74,000 doses of tuberculin. It will be noted that there was an increase for the year of more than 50 per cent in the amount of tuberculin sent out over that for the fiscal year ended June 30, 1903, when the total amount distributed was 47,358 doses:

Doses of tuberculin distributed, fiscal year 1903–4.

	Doses.		Doses.
California	152	Maine	123
Colorado	250	Maryland	344
Connecticut	54	Massachusetts	17,016
District of Columbia	239	Michigan	415
England[a]	600	Minnesota	19,294
Illinois	20	Missouri	112
Indiana	24	Montana	11,000
Iowa	450	Nebraska	201
Kansas	306	New Jersey	1,960

[a] For testing cattle offered for importation into the United States.

Doses of tuberculin distributed, fiscal year 1903–4—Continued.

	Doses.		Doses.
New Mexico	174	Utah	92
New York	993	Vermont	12,256
North Carolina	258	Virginia	12
North Dakota	135	Washington	3,926
Ohio	204	Wisconsin	3,010
Oklahoma	102		
Oregon	130	Total	73,912
Porto Rico	60		

THE TUBERCULIN TEST IN ENGLAND.

The work of the official veterinarian stationed at London, England, is in accordance with Order No. 79 of this Bureau, dated November 10, 1900, which provides for the testing with tuberculin by the inspector of this Bureau of all cattle over six months old which are to be imported into the United States for breeding purposes. During the year this work has diminished because of fewer importations of pure-bred animals. The inspector has tested of the different breeds in various parts of Great Britain and Holland as follows:

Results of tuberculin test in England and Holland of cattle for importation.

Breed.	Passed.	Rejected.	Breed.	Passed.	Rejected.
Shorthorn	11	3	Galloway	78	0
Aberdeen Angus	7	2	Holstein[a]	90	29
Ayrshire	4	3			
Guernsey	11	0	Total	202	37
Hereford	1	0			

[a] Tested in Holland.

BLACKLEG INVESTIGATIONS.

The routine work in the Pathological Division of preparing and distributing blackleg vaccine has been continued as heretofore. The number of doses sent out has fallen off somewhat, but the number of persons supplied is slightly greater than for the previous year. It is interesting to note that during the fiscal year 1903 over 1,000,000 doses of vaccine have been used and reported upon by over 10,000 persons with highly satisfactory results. The number of mistakes made may be accounted for by the number of persons making use of vaccine for the first time and their consequent unfamiliarity with its application. The appended tables give the quantity of blackleg vaccine distributed during the past year and the immunizing effects of the vaccine sent out during the previous year.

Doses of vaccine distributed during the fiscal year ended June 30, 1904.

July 1 to December 31, 1903:	Doses.
July	49,735
August	54,365
September	153,570
October	217,995
November	188,865
December	115,130

January 1 to June 30, 1904:	Doses.
January	84,290
February	71,630
March	147,600
April	138,055
May	71,175
June	44,440
Total	1,336,580

Results obtained from vaccine distributed during the fiscal year ended June 30, 1903.

State or Territory.	Number of reports.	Number of cattle vaccinated.	Deaths same season previous to vaccination.		Died after vaccination.					
			Number.	Per cent.	Within 48 hours.	From 2 to 7 days after.	Within 1 year.	Number of cases due to mistakes.	Total number.	Percentage of deaths.
Arizona	5	624	25	4.01	.....	1	4	1	6	0.96
Arkansas	14	917	46	5.01	.....	.....	3	.....	3	.32
California	518	76,991	1,251	1.62	12	43	304	.....	359	.46
Colorado	664	95,427	1,094	1.14	20	53	299	1	373	.39
Idaho	52	4,907	93	1.89	.....	3	15	.....	18	.36
Illinois	29	1,028	61	5.93	1	1	3	2	7	.68
Indiana	4	79	8	1.12	.....	.....	.....	.....	.....	.....
Indian Territory	94	11,064	406	3.66	5	11	35	.....	51	.46
Iowa	170	9,855	277	2.81	.....	4	43	7	54	.54
Kansas	1,358	114,249	2,679	2.34	17	60	257	105	439	.38
Kentucky	40	1,889	130	6.88	.....	.....	7	1	8	.42
Michigan	6	166	12	7.22	.....	.....	.....	1	1	.60
Minnesota	67	3,603	148	4.10	.....	.....	11	2	13	.36
Missouri	813	34,873	982	2.81	.....	28	127	38	193	.55
Montana	412	48,207	794	1.64	3	20	84	25	132	.27
Nebraska	2,132	167,173	3,390	2.02	4	59	643	221	927	.55
Nevada	2	259	10	3.86	.....	.....	.....	.....	.....	.....
New Hampshire	3	42	3	7.14	.....	.....	.....	.....	.....	.....
New Mexico	43	8,764	68	.77	.....	6	20	6	32	.36
New York	16	653	6	.91	.....	.....	4	.....	4	.61
North Carolina	20	740	45	6.08	.....	1	1	.....	2	.27
North Dakota	614	62,606	1,626	2.59	3	31	246	36	316	.50
Oklahoma	224	19,443	387	1.99	.....	21	76	6	103	.52
Oregon	143	19,288	368	1.90	.....	12	25	14	51	.26
South Dakota	613	53,285	1,299	2.43	8	41	269	50	368	.69
Tennessee	74	2,464	99	4.01	1	3	18	.....	22	.89
Texas	1,115	205,020	3,328	1.62	20	178	1,207	126	1,531	.74
Utah	25	5,364	29	.54	.....	5	4	15	24	.44
Vermont	4	75	2	2.66	.....	.....	.....	.....	.....	.....
Virginia	361	12,224	442	3.61	1	12	48	1	62	.50
Washington	24	965	2	.20	.....	.....	.....	.....	.....	.....
West Virginia	119	2,928	99	3.38	11	2	9	1	23	.78
Wisconsin	2	223	6	2.69	.....	.....	.....	.....	.....	.....
Wyoming	308	53,361	485	.90	1	22	149	11	183	.34
Other States	8	1,073	25	2.30	.....	.....	7	.....	7	.65
Total	10,096	1,019,829	19,795	1.93	107	617	3,918	670	5,312	.52

From the above table it will be seen that 670 cattle died as result of mistakes admitted by the stock owners, while 107 animals died of blackleg within forty-eight hours after the injection, thereby indicating that these latter animals were affected with the disease prior to vaccination. In determining the value of blackleg vaccine it seems proper to deduct these numbers from the total number of deaths following vaccination. After eliminating these deaths, which could not be attributed to any fault of the vaccine, the number of cases that died after vaccination is reduced to 4,535, or 0.44 per cent.

TEXAS FEVER.

An interesting condition relative to the persistence of the Texas fever organism in the blood of southern cattle after their removal from the so-called permanently infected territory was observed a second

time this year at the experiment station. In the year 1901 a cow injected with blood from an old southern cow, No. 113, became affected with Texas fever. In the year 1902 two cows injected with blood from the same southern cow failed to become affected, while two other cows injected with blood from another southern cow, No. 1, suffered attacks of Texas fever. At that time cow No. 113 had been removed from the permanently infected Texas fever territory thirteen years, and cow No. 1 seven years. In the year 1903 there was no test of the blood of southern cattle. This year (1904) two cows were injected with blood from southern cow No. 214, and four cows with blood from cow No. 113. The cows injected from No. 214 suffered with severe Texas fever, as a result of which one of them died. The four cows injected from No. 113 remained well. Two of the latter were subsequently injected with blood from No. 214, and one remained well, and the other became affected with Texas fever, thus showing conclusively that the absence of disease following the injection with blood from cow No. 113 was not due to immunity on the part of the animals injected. Cow No. 214, which unfortunately died this summer as the result of tuberculosis, was removed from the Texas fever territory in the year 1892; that is, thirteen years before the last injections were made. The infection in the blood of cow No. 113 persisted during twelve years, and was entirely absent in the thirteenth and fifteenth years after removal from all known sources of infection or reinfection. Cow No. 113 is now affected with generalized tuberculosis and will probably die in the course of the next few months.

In the biochemic laboratory during the past year a large number of analyses of oils and various dips recommended for the destruction of the tick known as *Boophilus annulatus* have been made, and, in addition, experiments have been instituted to determine the effect of these various dips upon these ticks and the relation of the composition of the various oils to their effect upon the ticks. This work, however, has not yet been completed.

The operations of the Bureau, as related to the control of Texas fever during the quarantine season of 1903, included the inspection and proper yarding at packing centers of 46,505 carloads of cattle from below the quarantine line, the number of animals being 1,350,623; also, supervision of the cleaning and disinfection of 45,589 cars.

There were also inspected in the noninfected area of Texas 179,116 head of cattle, which were permitted to be moved north for purposes other than immediate slaughter.

NECROTIC STOMATITIS OF CALVES AND PIGS.

The investigations on the bacteriology and pathology of so-called calf diphtheria announced in the last report have been brought to a successful termination. There will soon be issued a bulletin upon the subject, in which, as a result of careful and exhaustive study of the lesions, the name "necrotic stomatitis of calves" will be adopted in preference to the misleading term "calf diphtheria."

In the course of these researches a few cases of "sore mouth" in pigs were studied with the result that the peculiarly beaded filament of *Bacillus necrophorus* was isolated, and a demonstration obtained of its pathogenic relation to what we have called "necrotic stomatitis of pigs." The great difficulty in isolating the organism from diseased tissues and the peculiarity of its pleomorphism and anaerobic growth

have conspired to make the work slow and at times tedious. The bulletin will not only describe the character, cause, and treatment of necrotic stomatitis, but will also prove the entire absence of any connection whatever between the diphtheria in human beings and so-called calf diphtheria.

HOG CHOLERA AND SWINE PLAGUE.

The experiments concerning hog cholera and swine plague have been continued by the investigations in the biochemic laboratory and at the experiment station. As noted in Circular No. 41, issued October 1, 1903, certain new and apparently important facts concerning the etiology of hog cholera have been discovered. Under these circumstances it has been thought advisable to investigate thoroughly the etiology of hog cholera, in order that we may proceed more intelligently in our efforts to discover a cure or preventive for this disease. Therefore, during the past six or eight months our chief efforts have been directed to a study of the causes and methods of producing hog cholera; the great importance of securing a vaccine for this disease, however, is being kept constantly in mind. Certain methods of producing immunity, the value of which has not yet been definitely determined, are indicated in Circular No. 43 of this Bureau, which was published in February, 1904. The experiments concerning the etiology of hog cholera have been beset with many difficulties and adverse circumstances, but progress is being made, and it is confidently hoped that during the fall of the present year we may be able to publish the results of our investigations.

GLANDERS.

In December, 1903, an official of the Pathological Division was sent to West Point, N. Y., to confirm, if correct, the diagnosis of a supposed outbreak of glanders among the army horses at the United States Military Academy. Clinical examination of the suspected cases and necropsies on five of these animals showed the presence of glanders, which diagnosis was further confirmed by laboratory inoculations. A full report was made to Col. Albert Mills, Superintendent of the Academy, embodying recommendations for the testing of the horses with mallein, the disinfection of the stables, the isolation of the affected animals, and such other measures as are essential for the suppression and eradication of the disease.

During the year there have been prepared in the biochemic laboratory and distributed to various States and Territories 7,197 doses of mallein, which amount is approximately the same as reported for the previous year. The details of the distribution are as follows:

Distribution of mallein to States and Territories.

	Doses.		Doses.
Arizona	12	Montana	204
California	504	Nebraska	24
Colorado	54	North Dakota	608
District of Columbia	2,174	Ohio	462
Illinois	672	Oklahoma	136
Iowa	60	Philippine Islands	54
Kansas	30	South Carolina	60
Maryland	2	Vermont	60
Michigan	48	Washington	36
Minnesota	1,738		
Missouri	259	Total	7,197

RABIES.

Investigations regarding the presence of rabies in the vicinity of Washington, D. C., have been continued during the year. Of the 38 suspected cases examined, positive results have been obtained with 19 dogs, 2 cows, and 1 hog, of which number 13 were from the District of Columbia, 1 from Maryland, 7 from Virginia, and 1 from South Carolina. The results of the inoculation of oblongata emulsion and histological examination of the plexiform ganglia, together with the number of persons and animals bitten, and the species and origin of the animal affected, are given in the following table:

Results of inoculation tests and microscopic examination for rabies.

Date.	Record No.	Kind of animal.	Received from—	Result of inoculations.	Diagnosis by histological examination.	Persons or animals bitten.
1903.						
July 3	306	Dog	District of Columbia	Positive	Positive	1 dog.
July 27	308	do	do	do	None made	
Aug. 18	311	Hog	Norfolk, Va	do	do	
Aug. 24	313	Dog	District of Columbia	do	do	
Sept. 21	315	do	do	do	Not typical	
Oct. 5	317	Cow	Frederick, Md	do	None made	
Oct. 29	319	Dog	District of Columbia	do	Positive	1 boy.
Do	320	do	do	None made.	do	
Dec. 9	322	do	Norfolk, Va	Positive	do	1 girl.
Dec. 12	323	do	District of Columbia	do	do	
Dec. 31	324	do	Ridgeway, S. C	do	do	Dogs, chickens, and several persons.
1904.						
Jan. 27	325	Dog	Leesburg, Va	Positive	None made	
Feb. 6	326	Cow	do	do	do	
Mar. 16	327	Dog	District of Columbia	do	do	
Mar. 30	329	do	Rosslyn, Va	do	Positive	1 girl and several dogs.
Do	330	do	District of Columbia	do	None made	
Apr. 2	331	do	do	do	do	
Apr. 24	332	do	do	do	Positive	
Apr. 26	334	do	Norfolk, Va	do	do	2 persons.
May 4	336	do	District of Columbia	do	None made	
May 29	339	do	do	do	Not typical	1 dog.
June 11	341	do	Purcellville, Va	do	None made	

INFECTIOUS ENTERITIS OF PIGEONS.

Several reports have reached this Bureau during the past few months of a rapidly fatal disease among pigeons; and as the economic importance of it has been established, it is desired to institute a rigid investigation relative to the causative agent, the preventive and curative treatment, and the methods of dissemination.

Out of seven reported outbreaks 19 birds have been examined in the Pathological Division, which represent a total number of about 300 deaths, amounting to 25 per cent loss of those affected. An actively motile bacillus, belonging to the enteritidis group, has been isolated from the brain, heart, liver, spleen, and kidney of the dead birds; and when this organism has been tested on experimental animals, either by inoculation, feeding, or cohabitation, a similar disease is produced, from which the specific bacillus may be recovered. Thus far the organism has proved pathogenic for pigeons, rabbits, guinea pigs, and mice, and the resulting disease of these animals is characterized by marked intestinal inflammation, with fatty degeneration of the

liver and punctiform areas of necrosis in the liver and spleen. Further experiments are now being conducted.

EXPERIMENTS IN POULTRY FEEDING.

During the past fiscal year the results of the preliminary experiments conducted by the Biochemic Division to determine the digestion coefficients of some of the more common grains for chickens have been published as Bulletin No. 56 of this Bureau. These experiments involved a great deal of labor, inasmuch as they constitute almost pioneer work in this line with chickens. The following provisional conclusions may be drawn from the work already completed:

(1) The crude protein and nitrogen-free extract are assimilated in much greater proportion with corn than with oats.

(2) The availability of the crude fat of corn is slightly greater than that of oats.

(3) The digestibility of the crude fat of wheat is conspicuously less than that of corn and oats.

(4) Chickens consume a much greater quantity of corn than oats.

(5) The nutritive superiority of corn over oats is indicated by an increase in body weight when corn is fed, while there is a tendency to the opposite direction when oats is the sole article of diet.

(6) The nutrients of corn are fed at a lower cost than those of oats and wheat. This conclusion is based upon the actual availability of the various nutrients of the grains.

The poultry experiments are being carried further and involve the feeding of mixed diets of corn, oats, and wheat. From these experiments it is hoped that some data may be obtained which will be of practical use to poultry raisers.

INVESTIGATIONS OF THE PARASITES OF LIVE STOCK IN MONTANA.

An investigation of the parasites of live stock in the State of Montana was undertaken by the Zoological Division in May of the present year with the primary object of discovering a possible relation between the so-called loco disease of cattle, sheep, and horses and the presence of animal parasites. This investigation was confined entirely to Park County, where the disease has been prevalent for many years, entailing constant and serious loss among live stock, especially sheep. Many cases of the disease were seen among sheep, as high as 10 per cent of some flocks being affected. In the fall the percentage is higher and the symptoms more pronounced. Numerous autopsies were performed on diseased and on healthy sheep. One herd of cattle was seen in which two years ago 20 per cent were said to have been lost from the effects of loco. At the time they were seen, however, the animals were in good condition; only a few showed symptoms of the disease, and in so slight a form that it did not seem warrantable to sacrifice any for post-mortem examination. Two "locoed" horses were seen, and one was killed and an autopsy performed. For the purpose of experiments on the life history of their parasites and for further study of the loco disease, a number of parasitized and "locoed" sheep were procured for shipment to the zoological laboratory at Washington.

Numerous parasites were collected from diseased and healthy sheep

and from the locoed horse, some of them being species not yet described. A hasty biological examination was made of a number of small mountain ponds frequented by stock. Incidentally parasites were collected from prairie dogs, birds, fish, etc. A mite of an unknown species was collected from a prairie dog badly affected with mange. The notes and material gathered during the trip have not been worked up and therefore no definite results can be reported at this time.

MISCELLANEOUS WORK IN RELATION TO DISEASES OF ANIMALS.

Much attention has also been given in the Pathological Division to various minor subjects, among which are the following: The study of an outbreak of forage poisoning among the horses at Charlotte, N. C., and at Arlington, Va., in which no macroscopic or microscopic lesions of leucoencephalitis could be found; the experimental study of the *Aspergillus fumigatus*, and the preparation of an article, entitled "Aspergillosis of birds," based on this investigation; the publication of a paper on milk fever, with a description of an instrument for the application of the new air treatment; the preparation of an article regarding the pathological findings and inoculation experiments in a case of rabies in a woman; the monthly renewal of 89 stock cultures of different microorganisms which are maintained for exchange and comparison with those of other investigators; the preparation and installation of a pathological and bacteriological exhibit at the New England Exhibition of Arts and Crafts, Providence, R. I., and at the Johns Hopkins University, Baltimore, Md., on the occasion of the Maryland Tuberculosis Exhibition, and at the Louisiana Purchase Exposition, St. Louis, Mo.

In the Biochemic Division analyses were made of a large number of substances said to contain nicotine and which were submitted to the Bureau for its approval for use in the preparation of the nicotine dip for sheep scab. A large number of kretol dips were also examined chemically. A thorough chemical examination was made of a lot of ensilage supposed to be the cause of the death of a large number of horses and mules on the Department farm at Arlington, without, however, the discovery of any substances which could be held responsible for the disease in the animals.

Numerous identifications have been made in the zoological laboratory of parasites sent to the Bureau by veterinarians, physicians, farmers, etc. The collection has been increased by exchange and collection. An exhibit of parasites was prepared for the Louisiana Purchase Exposition. A bulletin (No. 60) concerning the nematode parasites of the eyes of chickens and other birds has been prepared and is now in press. This bulletin contains also an article on two important tapeworms of chickens. Mr. Stevenson, of the zoological laboratory, has prepared a circular on a hitherto undescribed parasitic nematode which was the cause of the loss of nearly the entire flock of fancy pigeons in which it was discovered.

The work of publication of the "Index-Catalogue of Medical and Veterinary Zoology" has continued, and during the year the "D," "E," and "F" authors have been issued, while the "G" and "H" authors are now in press.

AUTOPSIES ON WILD ANIMALS.

Postmortem work for the National Zoological Park continues to play an important rôle in the routine work of the pathological laboratory. Reports were made on 55 such postmortem examinations. A bacteriological examination of the tissues of many of these animals was made in order to determine definitely the presence of infectious diseases. These investigations, while only fruitful in the demonstration of a few such diseases, were nevertheless carried out consistently in those cases which seemed to justify it.

THE EFFECT OF PRESERVATIVES UPON DIGESTIVE ENZYMES.

The experiments instituted to determine the effect of various preservatives upon the digestive enzymes and upon the digestibility of milk have been completed. These experiments were conducted in the Biochemic Division, and the results are given in detail in the annual report of this Bureau for 1903.

WORK IN THE INTEREST OF THE DAIRY.

INSPECTION OF RENOVATED BUTTER.

During the year a large part of the work of the Dairy Division has been the administrative service assigned to it in connection with the act of Congress, approved May 9, 1902, concerning the manufacture, interstate commerce, and export of renovated butter. This has been the second fiscal year of the operation of this law, and the inspection service has become fully organized and well regulated. The ten dairy inspectors have been appointed upon certification from the Civil Service Commission, based upon special examinations, and the corps has proved efficient and satisfactory.

The law mentioned is now operating without friction, but experience for two years in its administration has developed certain features of weakness and indicated amendments which are needed for its greater efficiency. This subject will be presented as a special report at an early date.

The Treasury Department has reported 73 different factories having been licensed and bonded during the year for the manufacture of renovated butter, as against 82 for the year before. These were located in 14 States and the District of Columbia. Thirty-four of the factories have been in operation throughout the year; 9 commenced operations in July, 1903, but ceased manufacturing before the close of the year, and 18 began operating subsequent to July and continued until the end of June, 1904. One factory which was licensed did not operate.

During the year the dairy inspectors, assisted by the chief of the Dairy Division, have repeatedly inspected the renovated butter factories in operation and have inspected the markets in 274 cities and towns in 44 different States and Territories. The market inspections have been for the purpose of ascertaining the extent to which renovated butter is commercially distributed and the conditions under which it is sold at wholesale and retail. Advice has been given to many distributors and dealers as to maintaining the commercial identity of the article, questionable practices have been corrected, and inspectors

have cooperated with United States Treasury officials in enforcing the observance of the revenue features of the law.

The total quantity of renovated butter made at bonded factories during the fiscal year 1903–4 has been first reported (August, 1904) as 54,006,595 pounds. This is subject to revision when final reports are compiled. This shows a total rather less than the year previous, due to discontinuance of several small factories and a decrease of business by several others. But the larger factories nearly all report an output greater than the year preceding. The average production for the two years during which the law has been in force has been from 8 to 10 per cent greater than the estimated product of the 55 factories in operation during the year 1901–2.

Officers of the Department inspected 144 different lots of renovated butter for export, comprising 1,312,000 pounds, and certified the same to foreign countries during the first year of the operation of the law. During the second year, 367 lots have been inspected and certified for export, amounting to 3,118,018 pounds. Exports of this commodity have thus considerably more than doubled in quantity the past year.

INCREASE AND IMPROVEMENT OF RENOVATED BUTTER.

These facts show conclusively that the business of manufacturing renovated butter, as well as the exportation thereof, has prospered and materially increased since the act of May 9, 1902, took effect.

The average quality of renovated butter is still improving. The difference in general character between the product of the past year and the same commodity a few years ago is very marked. This is due in part to improved machinery and processes, and largely to the better average quality and condition of the "packing stock" or raw material used. Stock is now kept comparatively closely collected in the producing districts, so that accumulations of country butter at remote points and involving serious deterioration are of exceptional occurrence. More care is taken in sorting, packing, and storing the stock. Occasionally a lot of packing stock is found in such a condition of filth or putrefaction as to necessitate condemnation. In still rarer cases the manufactured product is found so bad, because of bad materials, ignorance, or negligence in renovating, or as the effect of age, as to make it unfit for food. In a few such instances the sanitary inspection required by law and made by this Department has caused the objectionable materials and products to be removed from the food market and sold as grease. But, as stated, such instances are very exceptional. Although there is still opportunity for great improvement in materials, in the manner of handling and transporting the same, in factory management, and in the finished product, it is true that manufacturers are endeavoring, as a rule, to improve conditions at all points and are ambitious to win a reputation for producing an article of high quality.

BUTTER FOR THE NAVY AND THE ARMY.

The Dairy Division has continued to assist in procuring butter for the use of the United States Navy by perfecting specifications for manufacture under contract and supervising the execution of contracts. Under this system, which includes inspection by officers of this division, over 700,000 pounds of butter have been purchased during the year by the Navy Department, and the latter has acknowledged the service

rendered and its satisfactory results. A much less quantity has been inspected for the Army, upon the application of purchasing officers of the Subsistence Department.

BACTERIOLOGY OF BUTTER AND CHEESE.

The experiments concerning the bacteriology of butter and cheese, which were mentioned in the last annual report of this Bureau, and which are being carried out by the Pathological Division and the Dairy Division, have been continued. The first report of this work is embodied in Bulletin No. 57, of the Bureau of Animal Industry, and deals with the keeping qualities of canned butter. The results described therein seem to indicate that the changes which occur in canned butter and which consist in the development of disagreeable flavors are probably due to the action of enzymes, which enzymes may be produced by the action of bacteria or secreted in the udders of cows. A second paper, Bulletin No. 62, entitled "The Relation of Bacteria to Flavors in Cheddar Cheese," has also been published. These experiments are being carried further to determine the source of the enzymes producing disagreeable flavors in butter, and also to determine, if possible, the best method of avoiding their presence in butter which is made under practical conditions.

LINES OF RESEARCH.

Several lines of original investigation have been inaugurated or continued during the year, as follows:

(1) An exhaustive inquiry into the possibilities and limitations of the dairy industry in the semiarid or "short-grass" region, embracing parts of Kansas, Nebraska, Wyoming, Colorado, and Oklahoma. This included a special study of the farm cream separator in its relation to the creamery system of butter-making under Western conditions.

Two reports by E. H. Webster, inspector and dairy expert in charge of this inquiry, have been published as bulletins in the Bureau series.

(2) A series of careful trials have been conducted at Chicago to determine the effect of different fixed temperatures upon the quality of butter in cold storage. This work has covered the greater part of the year, and the first or preliminary report is in preparation.

(3) Similarly, a series of trials in storing cheese at different temperatures has been conducted at New York. This report is also in preparation.

(4) In cooperation with the Storrs Agricultural Experiment Station at Storrs, Conn., an investigation has been commenced to determine specifically the principles involved in the manufacture of different varieties of soft cheese, such as are imported to this country from western Europe. It will be some time before any report can be made on this subject.

(5) In the dairy laboratory of the Bureau of Chemistry, and in the laboratory of dairy bacteriology of the Biochemic Division, Bureau of Animal Industry, investigations are being continuously carried on closely related to the dairy industry, if not bearing upon it directly. One report has been published upon the keeping qualities of butter, as noted above.

(6) Experimental exports of the best quality of creamery butter have been made weekly to Manchester, England, for several months, to make a practical test of the merits of such butter from the United

States in comparison with the highest grades of butter from all other producing countries, as found in the British markets. The results were favorable in a general way, but not such as to encourage commercial operations along the same line. No report has yet been published.

REPRESENTATION AT DAIRYMEN'S MEETINGS.

During the year an effort has been made to have the Department represented at as many as possible of the State dairy conventions in the several States. The chief and assistant chief of the Division and the dairy inspectors have attended these meetings. In all 28 such conventions have been visited in 22 different States and Territories. The work of the Bureau through the Dairy Division commends itself, as a rule, to these gatherings of representative dairymen in different parts of the country, and complimentary resolutions have been adopted by conventions in 18 States.

DAIRY WORK IN 1905.

The work of the Dairy Division during the fiscal year 1904–5 will embrace, in large measure, a continuation of that of previous years, with such additions as may promise useful results and are found practicable.

The condition of the dairy industry of the United States will be studied in all its aspects with a view to determining the most favorable opportunities and methods for progress and improvement and assisting in their accomplishment. The dairying of other countries will also be observed, productive conditions noted, the demands of consumption and of all foreign markets watched and such action taken as is possible in the interest of extending foreign trade in the dairy products of this country. Relations will be maintained with State dairy officials with a view to cooperation in the enforcement of laws; also with the voluntary organizations of dairymen and the dairy schools in numerous States in order to be informed of their proceedings and to cooperate so far as may be advisable.

The inspection of renovated-butter factories and markets will continue and be gradually extended and improved for the better administration of section 5 of the act of Congress of May 9, 1902.

The Dairy Division will conduct investigations by itself, as well as in cooperation with suitable agencies.

The experiments in storing butter at different low temperatures, which it was intended to continue and enlarge, have been abandoned because of the impossibility of finding available, in commercial storehouses, the necessary low temperatures with a guarantee of maintenance without material variation. The results of the cheese-storing experiments of the past year do not seem to warrant a repetition of this work. The soft-cheese investigation in Connecticut will be continued.

It is proposed to investigate the manufacture of condensed milk and promote such action as may be deemed expedient to preserve and enhance the reputation of this country for producing this article in a form suited to foreign markets. The comparatively new industry of making "milk powder" may also receive attention.

Many communications are received on the subject of improving the milk supply of cities and towns, and especially in securing greater

purity and sanitary conditions. It is proposed to cooperate in these efforts and to give such advice and assistance as may be possible in this desirable work.

In considering the future of the Dairy Division it should be first remarked that after nine years' existence the work in hand in extending present lines of effort and taking up new ones is much greater than can be accomplished by the original organization. The dairy industry is one of the most important and most extensive branches of American agriculture. Four-fifths of all the farms in the country keep cows for milk, 17,000,000 in number, and another million are reported "not on farms." The annual product of these 18,000,000 dairy cows has a value of about $600,000,000. The opportunities for improvement are manifest at many points. If the average cost of maintaining a cow could be lessened by intelligent economy, or the average dairy product slightly increased in quantity by rational treatment, or the average quality of dairy products raised a little by improved methods of practice, the aggregate additional profit would be very great. For example, one-third of all the butter produced in the United States is made in creameries and two-thirds on farms. The former, by reason of higher average quality, has a value of at least 3 cents per pound greater than the latter. If one-half the butter now made on farms could be made in creameries or in any way to make it as good as average creamery butter, the increased income to the producers would amount to $15,000,000 a year. Again, if the average municipal milk supply could be but slightly improved in quality and sanitary condition and the service correspondingly improved, the gain in the comfort and health of millions of people would be beyond measurement by dollars. Such improvements are entirely practicable and, in large measure, comparatively easy of accomplishment.

ANIMAL HUSBANDRY.

At the last session of Congress an appropriation of $25,000 was made for the purpose of enabling the Bureau of Animal Industry to conduct experiments in animal breeding in cooperation with the State experiment stations. Plans for this work have not yet been perfected, but arrangements have been made to conduct cooperative experiments in poultry breeding with the Maine Experiment Station in order to study the breeding of 200-egg hens, including the amount of floor space required per hen, and with the Pennsylvania Experiment Station, in addition to the work already in progress there, with the respiration calorimeter, to study the influence of age and individuality on the metabolism of beef cattle. Negotiations are in progress to establish cooperative experiments in horse breeding with the Colorado Experiment Station.

A cooperative experiment with the Colorado Experiment Station has recently been made to study the feeding value of sugar-beet pulp with alfalfa hay, with and without ground corn or ground wheat. The results will be published as a bulletin of this Bureau. The experiment seems to indicate that sugar-beet pulp has considerable value for steer feeding, either with alfalfa hay without grain or in connection with grain. The best results were obtained when grain was fed, but the hay-and-pulp ration was exceedingly economical and produced excellent gains.

The importation of families, breeds, and species of domestic animals of foreign countries, which are not known in the United States and whose use promises to be of value to our animal industry, has been started by the importation of four ewes and a buck of the native sheep of Barbados. These sheep are practically woolless, and are said to be valuable for mutton in warm climates. They were obtained through the courtesy of Sir Daniel Morris, imperial commissioner of agriculture for the West Indies. They will be quarantined at the experiment station of the Bureau of Animal Industry until their habits and qualities can be given careful study, after which the purpose is to send them to some point in the South for further trial.

REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Washington, D. C., September 1, 1904.

Sir: I have the honor to submit herewith a report on the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1904, together with a brief outline of the investigations now in progress and planned for the fiscal year ending June 30, 1905.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson, *Secretary.*

PERSONNEL.

During the year there have been added to the force of the Bureau 165 classified and other employees. Of this number 106 were assigned to scientific or related investigations and 59 to clerical and other similar work. The following shows the numerical strength of the Bureau on September 1, 1904:

At Washington, D. C.	304
Outside of Washington, D. C.	186
Total officers and other employees	490

Of the foregoing, 61 per cent are engaged in scientific and related work, while the remainder either aid directly in this work or serve to keep in shape the large amount of business transacted by the Bureau. The system of securing men necessary for the very rapid expansion of the investigations conducted by this Bureau is now working very satisfactorily. Where the work is permanent, or likely to be so, the employees are brought into the classified service. The Bureau has greatly felt the need at times of securing young men for the lower grades of service. This need has been partly met by the appointment, through the classified service, of scientific aids, who must be graduates of agricultural or other colleges whose courses of study are satisfactory to the Department. With the advances that have been made in our work it is seldom that a college-trained aid can come here and be assigned to any of the important independent problems that are before us. At least two years' service here is necessary to fit a man for even the minor independent field and laboratory problems. The Bureau has not been able to secure young men with proper qualifications rapidly enough. Recently, however, arrangements have been made for securing aids for

the lower grades of service. These aids are not required to be college graduates, but are expected to have a good common school education, and preferably high school training. To maintain proper eligible lists of such candidates it has been necessary to waive the civil-service regulations regarding apportionment, as these oftentimes work detrimentally to the securing of desirable men. It is designed to assign such aids to various lines of work. They are to assist in the laboratories, carry out field work assigned to them, and, in short, conduct any of the minor lines of investigation required. Where any of these young men or young women (for women are admitted as well as men) prove that they have proper qualifications, and bend their energies in the direction of better fitting themselves for more advanced work, they will be aided and encouraged in every way. Eligible lists for laboratory aids in pathology and physiology, in seed-testing work, and in horticulture have already been or will soon be established.

While there has been very just recognition of the question of salaries, so far as the scientific investigators of the Bureau are concerned, the Department is often seriously embarrassed by offers from the outside to our men who have made through their work unusual advances in scientific or other research. The Department can not hope to compete with commercial interests in the matter of salaries, and all of our scientific men recognize this fact. A majority of our best investigators remain in the Department for the opportunities that are offered here for work and the prestige such work gives. Owing to the manner, however, in which the Department investigations are conducted and the relationship which our men must necessarily bear to their work, they are sometimes at a disadvantage so far as remuneration is concerned, as compared with similar investigators in colleges. If a college man, through his scientific investigation, makes a discovery of direct practical importance, he is not precluded by his relation to the college from utilizing it as a means of securing extra remuneration. In fact it is oftentimes an honor to the college to have such offers made its best men. In the Department, however, the investigators can not, of course, accept anything of this kind, and all such services must be given gratuitously. While great advances have been made in the matter of salaries for scientific investigators in the last few years, the fact remains that they are still not as well paid as men doing similar work in our more important educational institutions. The salaries, for example, of the full professors in the leading colleges, such as Harvard, Columbia, Chicago, etc., range from $5,000 to $7,000 per annum. In such cases the work required is about fifteen hours per week, with three to four months vacation and one year in five or seven off, with full salary.

BUSINESS OPERATIONS.

The appropriation for the Bureau of Plant Industry for the year ended June 30, 1904, amounted to $809,930. This includes $110,000 set aside by your order from a special fund appropriated for work on cotton, with particular reference to the ravages of the boll weevil, and also $25,000 appropriated for the erection of new greenhouses on the Department grounds.

During the year there have been 3,637 requisitions issued, 6,150 accounts sent in, audited, and paid, 168 requests for contracts made, and 435 letters of authorization drawn. In the course of its regular

work the Bureau has sent out 120,000 letters on all subjects. The majority of these letters relate to practical questions coming within the scope of the Bureau's work. Our correspondence constitutes an important means of disseminating knowledge, as the subjects treated are of a varied character. Many inquiries can be answered by sending a bulletin or other publication, but those referred to here are such as require the preparation of a special reply.

As a part of the regular business operations of the Bureau, the preparation and publication of bulletins and other papers may be mentioned. During the year there were prepared and published 23 Bureau Bulletins, 8 Yearbook papers, 9 Farmers' Bulletins, and 14 miscellaneous documents, a total of 54 publications, aggregating 2,132 printed pages, and illustrated by 205 full-page plates and maps and by 323 text figures.

THE LOUISIANA PURCHASE EXPOSITION.

There was set aside for the exhibit of this Bureau at the Louisiana Purchase Exposition, held in St. Louis, the sum of $25,000. The exhibit as planned is divided into two chief groups, namely: (1) The exhibit inside, constituting the one in the Government Building proper, and (2) the outside exhibit of growing crops and plants in the open air.

The indoor exhibit covers 4,874.5 square feet, and is planned to illustrate the various lines of work conducted by the Bureau, and the practical application of these lines of work. The illustrative material consists of living plants and parts of plants, the products of plants, models, photographs, laboratory apparatus, and a full laboratory equipment illustrating methods.

In the exhibit of the pathological laboratory there are shown the diseases of cultivated crops, timber diseases, diseases of sugar beets, recent discoveries relating to nitrogen-fixing bacteria, recent discoveries relating to the growing of mushrooms, and recent discoveries showing the results accomplished in plant breeding.

In the botanical exhibit are living plants illustrating the work on fibers, pure-seed investigations, weed seeds, and adulterated seed.

In the drug exhibit there are shown methods of growing and handling crude drugs, how drug plants are cultivated, and how they are handled.

In the poisonous-plant exhibit there are shown plants poisonous to man and to live stock, and illustrations showing how the injuries from these plants are counteracted.

In connection with grass and forage plant work there are exhibited models of haying machinery, methods of controlling drifting sand and sand dunes, silo construction, and illustrations of important grasses and forage plants.

In the pomological exhibit are shown models of the principal commercial apples of the Mississippi Valley, new or little-known apples of the Mississippi Valley, models of a general collection of fruits grown in the United States, models showing methods of crating and packing apples, peaches, pears, and other fruits, a collection of standard pecans, etc.

In the exhibit of the Office of Seed and Plant Introduction and Distribution are shown illustrations of some of the more important introduced crops and the results of agricultural explorations.

In the cereal work there are shown some of the newly introduced grains, including durum wheat, Swedish Select and Sixty-Day oats, and other crops.

The outdoor exhibit covers 7½ acres of land, and its chief feature is an agricultural map of the United States. The States are made to scale, and the boundaries are indicated by walks 3 feet wide. Within the respective States are planted and grown the various crops peculiar to these States. There is also shown the proportionate amount of these different crops. The work on plant diseases is illustrated by growing orchard, truck, and other crops, some of which are healthy and some diseased. Methods of combating the diseases are illustrated, and the work on nitrogen-fixing bacteria is illustrated by field plots of inoculated plants. Plant-breeding investigations are illustrated by growing hybrids secured as the result of breeding work conducted by the Plant-Breeding Laboratory. The cereal investigations are illustrated by growing cereals of various kinds. The remaining portion of the outside exhibit is devoted to growing crops of fiber plants, drug and medicinal plants, poisonous plants, etc. There is also a school garden, in which the Bureau has the cooperation of the authorities connected with the public schools of St. Louis; a grass garden, illustrating the principal grasses and forage crops grown; and a series of plots illustrating crop rotation.

CONSTRUCTION OF NEW GREENHOUSES.

The new buildings planned for the Department have made it necessary to remove the glass houses now on the Department grounds. A special appropriation of $25,000 was secured for the erection of new houses suitable for the work of the Bureau. In view of the crowded condition of the grounds on the south side of the so-called parkway scheme, it was deemed best to put the greenhouses and conservatories on the north side. The new houses, therefore, are located in the northwest corner of the grounds. Eight modern iron houses, each 142 feet long, connected on the ridge-and-furrow plan, have been put up under contract. In addition to these houses the Department is putting up, by its own men and out of the funds of the Office of Experimental Gardens and Grounds, three additional houses. There has also been erected, in connection with the houses, a complete workroom for the packing and shipping of plants and for the necessary investigations that must be carried on in connection with the greenhouses. Two of the new houses will be devoted to work connected with the introduction and dissemination of rare plants and the growing of new plants secured as the result of breeding and selection. Two of the houses will be used exclusively for the pathological and physiological work; the remainder will be devoted to miscellaneous purposes. The contract for the new houses was let on June 1, 1904, and they are practically finished at this writing.

FARM MANAGEMENT.

The work of the Office of Farm Management has been inaugurated by a committee, working under the direction of the Chief of Bureau. This committee consists of W. J. Spillman, Agrostologist, chairman; A. F. Woods, Pathologist and Physiologist in Charge of Vegetable

Pathological and Physiological Investigations; A. J. Pieters, Botanist in Charge of Seed and Plant Introduction and Distribution; L. C. Corbett, Horticulturist in Charge of the Arlington Farm; William A. Taylor, of the Office of Pomological Investigations; and M. A. Carleton, Cerealist.

The primary object of the work of this office is to aid the farmer in adopting in actual practice the teachings of agricultural science, in so far as these relate to the production of crops. The following lines of work have been inaugurated:

(1) The gathering together of information concerning farm practice in all sections of the country as a basis for further work. This enables us to determine those sections in which improved methods are most needed, and gives us a better knowledge of the methods which are most successful in various parts of the country.

(2) The securing, for publication, of accurate records of the crops grown, the manner of growing them, the rotation practiced, method of handling manure, and of harvesting and disposing of crops on a number of typical successful farms.

(3) Encouraging farmers to visit and study work at experiment stations and on successful farms in their own sections. Seeing is believing—the farmer who sees the actual work of a farm will learn more than he possibly could learn from the printed page.

(4) To encourage diversification in farming in the cotton districts, where continuous clean culture of a single crop has impoverished the soil and induced wholly unscientific methods of tillage. To accomplish this, diversification farms have been established, which will be referred to more fully under the head of "Special work on cotton."

(5) The publication of outlines for systems of cropping for the different kinds of farming in all sections of the country. This work is new, and very little has as yet been published, but material is being gradually collected which will form the basis of a series of publications in the near future.

(6) The securing of data in regard to the methods of farm practice in the use of chemical fertilizers. Successful farm practice, under certain known conditions, will give valuable lessons where the practice is uniform. In other words, the data desired are for the purpose of correlating, if practicable, the use of known fertilizers under typical known soil and climatic conditions with successful production of certain crops.

(7) To furnish data in the matter of properly laying out farms, with particular reference to rotation and diversification of crops.

COOPERATION WITH STATE EXPERIMENT STATIONS.

The policy of the Bureau is to cooperate as fully as practicable with the State experiment stations. It is fully recognized that the stations have important duties to perform, and that their relations with the people of the State and the State authorities must be strengthened in every way. The Bureau is now working in various ways with the stations in twenty-six States and Territories, as is set forth in detail in later sections of this report.

COOPERATION WITH OTHER BUREAUS IN THE DEPARTMENT.

Early in the year an arrangement was made whereby the agent of the Bureau of Plant Industry in charge of timber-rot investigations was detailed to the Bureau of Forestry and placed in charge of Forest Products. The cooperative work with this Bureau with reference to investigations as to the seasoning and preservation of timber was carried on much as it was during the past year. Complete tables showing the loss of water in various species of wood, thus rendering them less susceptible to decay, were obtained, and a number of new processes for preserving wood were tested. Various other lines of investigation closely related to the work of both bureaus were carried on, and the results so far have been eminently satisfactory. Cooperative work has also been conducted with the Bureau of Chemistry along a number of lines. Investigations of cereals, investigations connected with the storage of fruits, investigations in bread making, and work on hemp and various other fiber plants have all been made the subject of cooperation.

EXPLORATIONS IN FOREIGN COUNTRIES.

During the year Prof. L. H. Bolley completed his work in Europe on the investigation of the flax industry and returning December 30, 1903, brought back many samples of seed. Mr. J. E. W. Tracy completed his study of sugar-beet seed growing in Europe. Early in the year Mr. Ernst A. Bessey was authorized to make a trip through the Caucasus region of Europe. Later, Mr. Bessey was again sent to Russia to secure seed of certain varieties of red clover, and in March and April of 1904 he went to Algeria to secure and ship a number of date palm suckers. With a view to increasing our knowledge of the nitrogen-fixing organisms, Dr. George T. Moore, of the Office of the Pathologist and Physiologist, spent about six months in Europe, mostly in Russia. Doctor Moore was able to secure from foreign investigators a number of cultures of important nitrogen-fixing organisms, and also through his observations and studies came into possession of a great many data which will be very valuable in further work along the line of supplying nitrifying organisms directly to the farmer. With a view to increasing our knowledge of tobacco, Mr. A. D. Shamel was sent to Cuba early in the year. While there he made an investigation of the tobacco industry, and secured seed from which to develop uniform strains of wrapper leaf tobacco in this country.

SPECIAL WORK ON COTTON.

Recommendations made in the last Annual Report led to a special appropriation of $250,000 for the study of cotton in the South, with special reference to meeting the ravages caused by the cotton boll weevil. Under the direction of the Secretary this fund has been handled jointly by this Bureau and by the Bureau (formerly Division) of Entomology. The appropriation became available early in February, and plans were at once made for inaugurating the different lines of investigation. The plan prepared jointly by the Chief of the Bureau of Entomology and the Chief of the Bureau of Plant Industry was submitted and approved by the Secretary. The lines of work decided upon and put into operation are as follows:

FARMERS' COOPERATIVE DEMONSTRATION WORK.—Forty thousand dollars was set aside for this work, the object being to inaugurate, especially within the boll-weevil infested district, demonstration work among farmers. The work was placed in charge of Dr. S. A. Knapp, with headquarters at Houston, Tex. A force of reliable agents was at once secured and the work of organizing the State begun. The primary object was to induce representative farmers throughout the State to adopt better methods of culture, with a view to avoiding the serious injuries produced by the weevil. The burning of old cotton stalks, the general destruction of infested material, the planting of cotton in wider rows, giving better and more cultivation, early plowing and early planting, the use of early-maturing varieties, and the application of fertilizers to hasten maturity and increase productiveness were the main lines inaugurated. The cooperation of more than 5,000 farmers was secured. A definite system of furnishing working plans was developed, and records are being made of the important operations throughout the season. Each farmer is growing under the direction of the Department from 10 to 20 acres of cotton, and each of these small areas will serve as an object lesson for a neighborhood. The work has led to the widest interest in general agricultural improvement, and has been highly beneficial in a number of ways.

PLANT-BREEDING AND SELECTION WORK.—This work was designed especially to secure by breeding and selection types of cotton better adapted to the climatic and soil conditions existing in the boll-weevil infested district. An effort is being made to secure early-maturing sorts and at the same time to have them more productive than the kinds now brought from farther north which are generally planted. In carrying out this work the main plantings of varieties were made at Terrell, Tex., where 170 acres of experimental cottons were put out. Many of the more important varieties have been brought together, and here the principal work in breeding will be carried on. With a view to broadening the usefulness of the work, however, plans have been made for growing demonstration plots in various sections, not only in Texas, but in Louisiana and adjoining States. The sum of $20,000 was set aside for this work for a period of twelve months, beginning January 1, 1904.

COTTON DISEASES.—Of the special fund, $10,000 was set aside for work on cotton diseases, especially the root-rot, which has been exceedingly destructive in Texas for a number of years. It is also planned to use a portion of the fund in the investigation of rust, wilt, and other diseases of Upland cottons. The breeding of wilt-resistant Upland cotton was undertaken on a large scale, about 40 acres being put in for the purpose. Demonstration experiments were undertaken to assist in the introduction of wilt-resistant Sea Island cotton in Georgia and Florida, and a large rotation experiment was begun to show the feasibility of controlling the root-knot in cotton and cowpeas by the use of immune crops.

INTRODUCTION OF NEW CROPS AND DIVERSIFICATION.—The plan for the introduction of new crops and diversification contemplated the encouragement of the growing of crops other than cotton, especially forage crops, cereals, etc. With a view to reaching quick practical conclusions, a plan was adopted for the organization of a number of

demonstration farms in Texas and adjacent Southern States. In conducting the work of these farms it was planned to secure the active cooperation of farmers in the immediate community, experiment station workers, and others. As a result, farms have been organized, or will be organized during the present season, as follows: In Texas, 16; Louisiana, 5; Georgia, 3; Alabama, 2; Mississippi, 3; South Carolina, 2; Florida, 1—total, 32.

The general method employed in locating, organizing, and conducting these farms is, first, to determine in what section of the State the various farms are to be located. An effort is then made to find a progressive farmer who is desirous of encouraging diversified agriculture in his section and who is willing to permit us to aid him in doing so. When a suitable arrangement has been made, representatives of the Department and the State experiment station make a thorough study of local conditions with reference to cropping possibilities, market advantages, etc. A system of records is instituted which will enable the Department to secure detailed information regarding every phase of the management of the farm and the results secured. When the system outlined has been put into practice, farmers' institutes are to be held in connection with the farm, and interested farmers are to be shown over the place and every detail of the operations explained and made clear to them. The expenses of the management of the farm are to be borne by the farmer himself. The sum of $20,000 was set aside for this work.

Cooperation with the Texas experiment station.—Cooperation is carried on with the Texas experiment station in connection with the breeding work. In addition, arrangements were made whereby the Department aided the station in its farmers' institute propaganda during the spring months, it being considered highly important to bring to the attention of as many farmers as possible the advantages of the various methods of controlling the cotton boll weevil. For cooperative work with the experiment stations in the matter of farmers' institutes the sum of $25,000 was set aside. Assistance was rendered by the agents of this Bureau at a number of important meetings.

Investigations of tropical cottons.—Soon after the appropriation for special work on cotton became available it was determined to send Mr. O. F. Cook, our agent in charge of investigations in tropical agriculture, to Guatemala and other Central American States for the purpose of studying tropical cottons. In previous visits to this region Mr. Cook had discovered that cotton was grown in certain sections despite the presence of the weevil. Mr. Cook left for Guatemala early in February, where he began his investigations at once in the somewhat inaccessible region of Alta Vera Paz. His investigations here led to the discovery of the kelep, or boll-weevil-eating ant, which has already been quite fully discussed in publications of the Department, and has been introduced and is now being observed and studied in Texas. After the successful introduction of this ant by Mr. Cook, arrangements were made for its further study under the direction of the Chief of the Bureau of Entomology. In order to carry out this plan, Mr. Cook was assigned to the Bureau of Entomology for the investigations in question. He will continue his work on the kelep ant, and at the same time will carry forward his investigations of such problems relative to cotton varieties and the cotton itself as come strictly within the prov-

ince of this Bureau. For Mr. Cook's investigations the sum of $1,800 was set aside, this amount being taken from the reserve fund of $79,700.

REPORTS OF EXECUTIVE OFFICERS.

In the accompanying reports are given summarized statements of the principal officers of the Bureau.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

The pathological and physiological work of the Bureau, directed by Mr. Albert F. Woods, is divided among ten principal laboratories and special lines of investigation, covering 48 special groups of problems which are briefly reviewed under the following heads:

PATHOLOGICAL WORK.

GENERAL INVESTIGATIONS.

Dr. Erwin F. Smith and his assistants in the Laboratory of Plant Pathology have, as in the past, given much time to microscopical and cultural examinations of diseased plants sent to us by farmers, fruit growers, and horticulturists from all parts of the United States, our insular territories, and from foreign countries, requesting information as to the causes of the troubles and their remedies. The work on the gum disease of sugar cane has been continued in the laboratory and greenhouse. A very destructive bud rot of the cocoanut palm has been studied in the West Indies, and a preliminary report is now in preparation. Considerable progress has been made in the investigation of "olive-knot," of a bacterial disease of sweet corn, of cucurbit wilt, and of the bacterial spot of plums. Reports on the cucurbit wilt and on the black spot of plums are ready for publication.

Dr. C. O. Townsend completed the study of the bulb rot of the calla lily. The cause was demonstrated to be bacterial, and a means of avoiding the trouble through cultural methods was found. A report on the subject has been issued.

DISEASES OF SUGAR BEETS.

Doctor Townsend has continued the investigation of sugar-beet diseases along the same lines as reported last year. The spraying experiments for leaf-blight demonstrated again that Bordeaux mixture, properly applied, will prevent leaf-spot. The cause of the disease known as curly-top has not yet been found, and no remedy is known. The results of selecting resistant strains will not be known until the end of the next beet season.

DISEASES OF ORCHARD FRUITS.

The special work on the diseases of orchard fruits has been continued by Mr. M. B. Waite, assisted by Messrs. W. M. Scott and P. J. O'Gara.

PEAR-BLIGHT.—The work on pear-blight for the past season has been almost entirely devoted to continuing the demonstration work. This has been carried out in Georgia and in Maryland. The object is to test the efficiency of continued and thorough cutting out of the blight, espe-

cially in the autumn and spring. The work was continued in two orchards, one in north Georgia and the other in south Georgia, referred to in our last report. It was only partially successful this year. Blight appeared in both orchards to a considerable extent, but was practically exterminated in each case. The actual field work was carried out, under the direction of Mr. Waite, by Mr. O'Gara. The work of crossing to secure resistant new varieties of pears was taken up again and a large number of crosses were made.

LITTLE-PEACH.—In little-peach, the season's work was devoted largely to carrying out a thorough eradication test. As mentioned in last year's report, our investigations, with the experience of certain orchardists, led to the belief that little-peach could be handled by the same method used to control the "yellows," namely, by complete eradication, provided this eradication were carried out over a considerable area. A section of 3 square miles or slightly more was selected in the heart of the little-peach district in Allegan County, Mich., and the orchards were thoroughly gone over three times during July, August, and September, and every identified case of little-peach was destroyed. The experiment is to be continued for at least three years.

BLACK-HEART OF APPLE.—A disease of young apple trees, principally in the Mississippi Valley States, known as black-heart, has attracted attention, and is now under investigation by Mr. O'Gara.

WINTERKILLING OF FRUIT TREES.—The extreme cold of the past winter caused very serious winterkilling of fruit trees in New York and in New England. Our attention being called to this matter through several fruit growers, Mr. Waite was instructed to proceed to the frozen orchards and to make a careful examination. On account of the very unusual character of this freeze, few orchardists understood exactly the extent of the damage and were at a loss as to the proper procedure. There was a tendency to overestimate the damage and to cut back or pull up the trees. Very many frozen trees, while seriously injured and discolored, were not killed. Our previous experience with frozen trees in Michigan, Missouri, and Georgia enabled us to predict very accurately what could be expected from the trees in various stages of discoloration. A brief report, intended as a guide to the owners of frozen trees, was promptly issued. This, it is positively known, saved many orchards from useless destruction, and was otherwise useful to orchardists in this emergency. An examination of the frozen orchards in June showed that Mr. Waite's predictions were accurate. The orchards injured in varying degrees turned out exactly as was expected.

BROWN-ROT OF STONE FRUITS.—Like the bitter-rot, brown-rot is one of the unpromising and difficult subjects in orchard pathology. So far we have no satisfactory method of dealing with this disease. We may be able to reduce it to some extent, but to prevent it, as we do pear leaf blight or even black-rot of grape, has not been accomplished. The subject has been assigned to Mr. W. M. Scott, who is now making a thorough investigation of the disease, to be continued over a series of years. In this investigation the field work will be carried on mainly in Georgia. Practical field tests were made in spraying and dusting with various mixtures, and in employing different methods of pruning and cultivation, while extermination by gathering up the rotting fruit was

tested. Careful laboratory studies on the parasite will be continued. On this last line satisfactory results have already been secured. A large number of crosses for the purpose of securing varieties resistant to the disease were made.

DISEASES OF VARIOUS PLANTS.

TOBACCO DISEASES.—The most serious disease of tobacco in the United States during the past season has been the relatively new malady called wilt. In Granville County, N. C., and in that vicinity, the spread of the disease has been so rapid as to threaten the complete destruction of the large tobacco industry of a district which until recently was one of the best in the State. Field and laboratory studies have been made of the disease by Dr. R. E. B. McKenney, and a brief preliminary paper (Bulletin No. 51, Part I, Bureau of Plant Industry) was published, giving a description of the disease and the methods to be used in controlling it.

Extended field studies were made on the diseases occurring in most of the prominent tobacco sections of the country. Among the diseases receiving most attention, in addition to the wilt, there may be mentioned mosaic, ring-spot, frog-eye, and white-speck. Considerable laboratory work has also been done on the mosaic and ring-spot diseases, as well as on the new root-rot in Connecticut. The preparation of a general bulletin on tobacco diseases, embracing the results of this and previous work, is now nearing completion.

BANANA DISEASE.—Doctor McKenney was sent to Central America for the purpose of studying a so-called mosaic disease of bananas. Field observations indicate that the trouble is not due to mosaic disease, but to root asphyxiation and partial nitrogen and potash starvation, as a result of improper soil drainage and lack of cultivation.

WILT DISEASES.—Mr. W. A. Orton has given his attention mainly to investigations of (1) cotton, cowpea, and watermelon diseases, with special reference to wilt and related troubles; (2) pecan diseases; (3) diseases of truck crops. The development of each of these lines of work is summarized below.

Wilt in Sea Island cotton.—The success of our wilt-resistant varieties of cotton was more marked last season than ever before. An improved selection from the Rivers cotton remained entirely free from wilt on the worst infected land on James Island, South Carolina, and was not only more productive, but had a finer and better staple than the original nonresistant strain, thus disproving the contention that resistance to wilt had been obtained at the sacrifice of quality. A new resistant variety was originated that surpassed any previous record for productiveness. This was intended for cultivation in Georgia and Florida, and promises to be well adapted for these sections. The improvement of the general condition in the interior regions adapted to Sea Island cotton is now our main object. An unfavorable season prevented a fair test of last year's distribution of the Rivers cotton, but 200 additional bushels of seed have been distributed this spring. The reports sent in last autumn are quite favorable on the whole and indicate that the variety will be very successful under better conditions. Variety tests and breeding and rotation experiments are under way on James Island and at Blackshear, Ga.

Wilt in Upland cotton.—Plant-breeding work for the production of resistant varieties has been continued on a larger scale this year on account of the increased appropriations. Last year's results were very encouraging. A strain of Jackson cotton has been nearly fixed in its resistance to wilt, and a trial distribution of over 40 bushels of seed was made this year.

Cowpea wilt and root-knot.—The Iron cowpea has proved a great success nearly everywhere. A second distribution of 200 bushels of seed was made this spring. This work is being developed as an auxiliary to the cotton-wilt investigations, as it has been found that many thousand acres of sandy soil in the Gulf States are infected with both the wilt and the root-knot, and there the cultivation of the ordinary cowpea results in great injury to cotton. The Iron cowpea meets most needs, but other varieties adapted to special uses are desired. The hybrids made two years ago gave surprising results last year with regard both to productiveness and disease resistance. They are being tested on a larger scale this year. Other forage crops are also being grown in demonstration experiments to show how these diseases may be combated by a rotation of crops.

Watermelon wilt.—The plant-breeding work carried on last year to produce a wilt-resistant variety of watermelon gave all the results that could have reasonably been expected. The hybrids with the citron proved very resistant, although the first crosses were not edible. A double cross, containing three-fourths Eden melon and one-fourth citron, gave several melons of good quality. Seed from them is now growing in eight isolated plots in order to fix the type. This breeding work has been greatly extended this year by cooperation with the North Carolina experiment station. Twenty acres are devoted to resistant hybrids and variety tests. An assistant, Dr. W. G. Sackett, is employed to carry on this work during the summer.

Shedding of cotton bolls.—An investigation of this important problem was actively begun this year in cooperation with the Alabama experiment station. Extensive field experiments are under way. Anthracnose and other diseases of cotton are being studied as opportunity allows.

Pecan diseases.—Work on diseases of this important nut has been continued during the year. The scab has been found to be caused by the fungus *Fusicladium effusum*. This was more destructive than usual last year, and this season experiments are being made, in cooperation with the Georgia State entomologist, in the control of the disease by spraying with Bordeaux mixture. The rosette disease has been found to be very common and destructive throughout the Southeastern States. The cause is still unknown, but the disease is believed to belong to the "yellows" group. Field experiments and laboratory studies are in progress.

Diseases of truck crops.—An outbreak of the downy mildew of cucumbers was investigated last year at Charleston, S. C., and this spring a demonstration experiment was carried out to show how it could be controlled by spraying with Bordeaux mixture. In connection with this work we were able to perfect a spraying apparatus adapted for work on a large scale. Potato diseases have been given some attention, particularly in regard to southern problems and the

question of breeding varieties resistant to Phytophthora in the North. A general survey of the trucking sections of the South Atlantic Coast was made. Work on this class of disease can be greatly developed if there is opportunity.

Root-rot of cotton.—The study of the fungus producing cotton root-rot has been continued by Mr. C. L. Shear and Mr. George F. Miles, but the life history of the fungus has not been positively determined. The inoculation experiments in the greenhouse have all failed for some reason. This failure of the disease to attack plants in the greenhouse would seem to indicate that the equilibrium between the plant and its environment was of a rather delicate nature, and the attack of plants by the disease or their freedom from it depends upon a slight change of various factors. Inoculation experiments with pure cultures of some of the fruiting forms of fungi suspected of being connected with the root-rot are to be made in the field this season. The work is being carried on along three lines, chiefly, (1) selection of resistant varieties; (2) applications of fertilizers and chemicals; and (3) rotation of crops. About one hundred selections of plants appearing to be immune to the disease were made last autumn, and the seed from these plants is now being grown on a badly diseased area in order to determine whether the plants are really resistant or not. It is hoped that a sufficient number of these plants may prove immune to give us a quantity of seed for use in the propagation of an immune variety. It is too early at present, however, to tell how many are really resistant, as the disease is but just beginning to develop in the field. Applications of various fungicides and fertilizers to the diseased areas have been made, but it is yet too early to note any results. In the rotation of crops a three or four year rotation with wheat, sorghum, or millet, according to the experience of many cotton planters, is sufficient to free the soil from the trouble and make it possible to grow cotton with little loss for several years afterwards. This at present seems to be the most practicable means of avoiding or controlling the disease.

Cranberry diseases.—The work on cranberry diseases has been continued by Mr. Shear. Three fungi are found to be associated with the most destructive diseases, known as blast and rot, or scald. A part of the so-called scald of cranberries is produced by a species of Gloeosporium, not satisfactorily determined as yet. This has been found to some extent in Massachusetts and is apparently the chief cause of the small amount of rot which occurs in the Cape Cod region. It also produces a part of the trouble in New Jersey. An apparently undescribed pyrenomycetous fungus, which we have called temporarily "Acanthostoma," evidently produces a considerable amount of the so-called "scald." The greater portion of the trouble in New Jersey, however, is due to a species of Guignardia. The life history of this fungus has been determined in the laboratory. Its pycnidia often occur on the leaves and very young fruit, producing what is generally called "blast." It attacks the fruit soon after the falling of the flowers and destroys in this way in many instances as much as one-half the crop. It also fruits abundantly on the small berries, and in this manner is apparently widely distributed. It also attacks the full-grown fruit, but rarely reaches a fruiting condition on the mature berries. The difference in the appearance of the fruit which is attacked by these three fungi is so slight that it is difficult to tell from an inspection

which fungus has caused the trouble. Inoculation experiments have not yet been made, on account of the difficulty of growing fruit successfully in the greenhouse. It is our intention to do some inoculation work in the field this season. However, the presence of one or the other of these fungi in the diseased fruits and the occasional fructification of them on partly grown fruits, as well as on the very young fruits and leaves, seems to leave little doubt of their relation to the disease. Experiments in remedying or controlling the disease were conducted last season and gave decided indications of success. Plots were sprayed with various fungicides at three different places and decided benefit resulted in all these cases, notwithstanding the fact that many circumstances interfered to prevent the greatest success. More thorough and extensive experiments, especially in the application of Bordeaux mixture, have been commenced this year, and we hope to determine more exactly the amount of benefit which can be derived and also the most practicable and economical methods of applying the mixture. Some of the most progressive cranberry growers are taking a very active interest in the matter, and we believe that we shall ultimately be able to control the diseases to a great extent.

WORK IN PLANT BREEDING.

The work in plant breeding is conducted by the Laboratory of Plant Breeding, under the immediate supervision of Dr. H. J. Webber. Following is an outline of the main lines of investigation carried on during the past year.

IMPROVING COTTONS.

Long-staple cottons.—Within the last thirty years a number of long-staple Upland varieties of cotton have been originated and these have come to be cultivated to some extent in certain parts of the cotton belt, and very generally in the rich bottom lands of the Mississippi and Red rivers in Mississippi, Arkansas, Louisiana, and Texas. These cottons, which range in length of lint from $1\frac{1}{4}$ to $1\frac{3}{8}$ inches, are finer than ordinary cotton and more valuable. A large number of hybrids were made several years ago, and certain types were selected from among these which seemed in large measure to fulfill the requirements for long-staple forms. These have been subjected to the most careful selection for the last four years to reduce them to a fixed type and improve their qualities in certain important directions, such as yield and strength of fiber. Several of them are approaching fixity of type, and will probably be ready for distribution in a few years. Among these are varieties ranging in length of staple from $1\frac{1}{4}$ to $1\frac{5}{8}$ inches. The sorts having fiber from $1\frac{3}{8}$ to $1\frac{5}{8}$ inches in length are being bred to smooth black-seeded types, so that roller gins may be used with them if desired.

Short-staple cottons.—Experiments are in progress in the careful seed selection of some of the short-staple cottons, the aim being to secure ultimately pedigree seed for distribution.

Egyptian cottons.—The experiments in the introduction and establishment of Egyptian cottons in this country which were started in 1900 are being continued. Selection experiments with different varieties are being carried out in Texas, South Carolina, Georgia, Arizona,

New Mexico, and California, and great improvement in yield and length of staple has already been secured. Since our last report careful manufacturing tests have been made of different varieties of Egyptian cotton grown in South Carolina, Georgia, Texas, Arizona, and California, and the results obtained were very favorable to the American-grown product. In comparison with a good grade of imported Mit Afifi Egyptian cotton manufactured at the same time, the waste was much less than the average, only 4 out of 11 samples being below the Egyptian; while the breaking strength of the yarn manufactured from the American product was much greater than in the Egyptian staple, only 2 of the 11 American samples falling below the imported yarns. There is a tendency for the brown Egyptian varieties to produce a rather lighter color in this country, but the two sorts which have been grown and selected for four years in South Carolina are still fully as deep a brown as when they were first imported. Samples of these cottons have been submitted to expert buyers and manufacturers, and in almost all cases the American product has been pronounced equal to the imported. The experiments already conducted show conclusively that we can grow in the United States as good a quality of fiber of Egyptian cotton as is grown in Egypt, but the yields have not been brought up sufficiently to render them as profitable for general culture as our native varieties. It is believed, however, that this can be done by a few more years of careful selection.

IMPROVEMENT OF CORN.

Selection experiments.—Experiments in the improvement of corn have been carried on, as in past years, by Mr. C. P. Hartley. The main line of work under way has had for its object the selection of strains of corn best adapted to the different sections of the United States. The work is being conducted in cooperation with twenty or more State experiment stations and many farmers. Each year the Department obtains pure seed from the originators and breeders of the leading strains of corn in various sections of the country and is sending this seed to different localities for comparative tests.

Handling of seed corn.—The proper handling of seed corn in the ear is being encouraged by the Department whenever possible, because it is one good means of leading to the use of better seed, and the use of better seed will in many instances, without extra expense, increase the yield by 15 bushels per acre. This has been demonstrated by plantings made in several States.

Investigations in corn cultivation and seed selection.—During the year the Northern, Southern, and Western States were visited for the purpose of studying the prevailing methods of corn cultivation and seed selection. The results of some of these studies have been published in the Yearbook and in Farmers' Bulletin No. 199.

Breeding and hybridization work.—Work in hybridization and selection for the purpose of securing sweeter, more tender, and more productive strains of sweet corn for table use has been carried on during the year. These investigations are being conducted in cooperation with a number of canning factories and others interested in the securing of better strains of sugar corn suitable for canning.

Investigations regarding the effects of hybridization, the transmission of stalk, leaf, ear, and kernel characters to the progeny, the system of root formation and its relation to methods of cultivation, and the effect upon production of kiln-drying and air-drying seed corn have been carried on at the Arlington Farm and on the Potomac Flats near Washington, D. C. The results of this work are corroborative of the commonly accepted belief that seed from individuals having peculiar or desirable forms of stalk, blades, ears, or kernels will produce crops bearing the characters of the parent.

IMPROVEMENT OF OATS.

The breeding work with oats was continued by Mr. J. B. Norton, being mainly directed to the production of a profitable variety for the rich farm lands of the great corn-growing States, where oats are used in rotation with corn. The production of a more desirable oat for meal constitutes a part of this work. Some very promising hybrids have been obtained from the naked oat of China—the so-called "European hull-less oat." With the present methods of oatmeal manufacture the demand is for a thin-hulled, large, heavy-grained variety, without double oats.

IMPROVEMENT OF POTATOES.

Work on the breeding of potatoes is being conducted along two lines—(1) tuber selections and (2) the production of new seedling varieties. This work was begun in 1902, and has been conducted mainly at the Arlington Farm, but this year was moved to Massachusetts in order to insure better production of seed balls. Many of the seedlings secured as a result of the first year's selection already give promise of much value.

TOBACCO.

Improvement of types by breeding and selection.—Important work on the breeding of tobacco has been inaugurated under the direction of Mr. A. D. Shamel. Investigations are being carried on along two principal lines—(1) selection of individual types in the varieties and (2) crosses between different varieties. Great variation in all the varieties of types of tobacco investigated has been found, and this variation forms the basis for selection. The different plants vary in number of leaves, shape of leaves, quality of leaves, time of maturity, amount of seed produced, number of suckers, and ability to resist unfavorable climatic and soil conditions and disease. These variations occur in the field in such a manner as to leave no doubt that they are due to the seed and not to soil and climate. The work being conducted has shown unquestionably that the desirable characteristics can be fixed from the first year's selection. In the selection work 9 different types have been used and more than 300 selections have been made of each type. One hundred and twenty-five plants are used as a standard for each selection. Thus the work of selection alone has involved the handling of something over 40,000 plants. The selected plants have been grown under tent shade, and the entire development of the leaf will be followed and its value determined by a thorough test of burning qualities, aroma, etc.

Experiments with heavy seed.—It has been found that there is a decided advantage in using heavy tobacco seed. The heavy seed pro-

duces the earliest and most thrifty young plants, while the light seed produces plants of low vitality and less vigor of growth. Inasmuch as it is a simple matter to separate the light from the heavy seed, it is important that this fact be brought prominently to the attention of the growers. Apparatus is being devised that will enable the growers to make these separations easily and at practically no expense.

Improvement of tobacco by hybridization.—Owing to the peculiar structure of the tobacco flower, crosses are easily made, and from the great number of seed produced in each ovary, varying from 3,000 to 7,000 seeds per pod, the work of securing new types by breeding is not difficult. From the evidence already obtained by experiments in the Connecticut Valley it is believed that the improvement of tobacco by crossing is practicable and can be successfully carried out according to the plans now in operation.

CITROUS FRUITS.

Plan of distributing new fruits.—Some of the new citrous fruits, obtained as the result of breeding, are practically ready for distribution. Two of the hardy oranges give promise of value as a fruit for a large portion of the South. The kid-glove pomelo, referred to in my last report, is also a valuable new type, and preparations are now being made for its distribution. The same is true of the hybrid between the pomelo and the tangerine orange, which has resulted in a fruit which we have called "tangelo." All of these fruits are now on hand in considerable quantity and their distribution will begin early this autumn. It is planned to properly name the fruits and distribute with them full descriptive matter, in order that a complete record of their origin may be retained.

IMPROVEMENT OF PINEAPPLES.

The work on pineapple improvement has been continued, and many more interesting types have fruited. One of the primary objects of the investigation was to secure new smooth-leaved sorts, as only one smooth-leaved variety is now cultivated and the serrations on the leaves of the other varieties render the plants very difficult to handle. A large number of the hybrids which have fruited are of superior quality and flavor. Their hardiness and adaptability to general culture, however, require to be more thoroughly tested before they can be distributed.

IMPROVING SUGAR-BEET SEED.

Single-germ beet seed balls.—The problem of producing a strain of beets that will give seed balls containing but a single seed instead of a number, as is now the rule, has been placed in charge of Dr. C. O. Townsend. The advantages resulting from securing seed of this kind would be great, as such seed would undoubtedly save much labor in planting and thinning. About 1,000 mother beets secured from single-germ balls will produce seed this season. These will receive careful attention, and the selected seeds from these plants will be used in the future work along this line. Nearly 100,000 single-germ balls were planted this year for the production of mother beets for next year's work. Part of this work is carried on at the Arlington Farm

and part in Colorado, Utah, and Washington. Some of the work in Utah has yielded very satisfactory results, a number of plants having given as high as 30 per cent of single-seed balls.

ALKALI-RESISTANT CROPS.

WORK ON RESISTANT FIELD CROPS.—The work now in progress at several stations in the West and Southwest has in view the producing of strains of the more important field crops which will prove resistant to alkali in the soil. Experiments with alfalfa, wheat, barley, oats, and other crops have been carried on under the immediate supervision of Mr. T. H. Kearney. The various pieces of alkali land are selected after a thorough examination of the amount of soluble salts present in different parts of the field, and the seed is planted in such a way that each stand is exposed to different amounts of alkali in different parts of the field. Other crops, such as cotton, wheat, etc., are also under investigation. The work promises to be of great practical importance, not only in indicating what varieties can be chosen with the greatest hope of success for growing on alkali land in general, but also what varieties are best suited to each of the several types of alkali found in the western soils.

CEREAL INVESTIGATIONS.

The work with grains has been carried on during the year by Mr. M. A. Carleton and his assistants on about the same lines as indicated in the previous report, with some additional investigations.

IMPROVEMENT IN WINTER WHEATS.—The experiments with winter wheats have been continued during the present year and will require at least another year for completion. Winter wheat is not only now a common crop in Nebraska, but it is being grown much more largely than before in northern Iowa. During the year a number of experiments have been made in North Dakota and South Dakota with success in the survival of the hardier varieties in South Dakota and one very successful result at Lisbon, in North Dakota. The further experiments with these winter grains indicate that the excess in yield per acre of winter wheats over that produced by spring wheat on the same land is even greater than we have supposed. The increase is sometimes from 30 to 50 per cent. There is, besides, less liability to damage from insects and fungi in the winter wheats, and the appearance and quality of the grain usually are better.

WINTER GRAINS FOR THE SOUTH.—Some of our most interesting and important work now is being done in the development of hardy winter varieties of barley and oats for the South. Much of this work has been carried on in cooperation with the Tennessee Experiment Station. At that station a variety of barley, called Tennessee Winter, has been developed, which is already found to be sufficiently hardy for a large portion of the South, and this last year has survived in good condition even in Maryland and Kansas. This variety is now being distributed, with much profit to southern agriculture. No variety of oats has yet been produced or discovered sufficiently hardy to withstand the winter in every season or very far north. The Culberson Winter, however, has proved very satisfactory over a large area, and it is hoped through selection in the future to make it a still hardier

variety. Other new varieties are under experiment, some of which promise to be important for general cultivation.

Durum (macaroni) wheat.—Still better results are being obtained each year with durum wheat, and the present outlook is very good for a large production in the future. The success of the durum wheat from a commercial standpoint is now practically as certain as its success was known to be formerly from the farmer's standpoint. The crop of 1903 consisted of at least 6,000,000 bushels and possibly more. About 1½ million bushels have been shipped to the Lake cities and exported to foreign countries. About half a million bushels have been fed to stock or used for seed, leaving 4,000,000 bushels which appear to have been consumed entirely by the local flour mills, much the larger part of which was used in making bread flour. There was an unusual demand for the wheat in the latter part of the winter at Duluth, Buffalo, and New York. On December 31, 1903, No. 2 macaroni wheat sold for 81 cents, c. i. f., Buffalo. The price was 80 cents on January 8, 1904, and on February 27, 1904, the same grade reached $1.02 per bushel, with practically none to be obtained. At Buffalo $1 has since been offered for No. 2. Further experiments have been made during the year in the use of the wheat for bread, the results of which are soon to be published. In addition to the considerable quantity of macaroni now made by several factories, a number of breakfast foods are made from this wheat. Fifteen million bushels, or possibly 20,000,000 bushels, of this wheat are likely to be produced in the coming harvest.

It would be a very valuable accomplishment in certain sections to be able to grow the durum wheat as a winter crop. Efforts are being made to discover or develop varieties sufficiently hardy for this purpose, with already a considerable prospect of success. A few varieties during the last season survived the winter very well under conditions usually too severe for this grain. It is expected that these varieties will become still hardier after rigid selection.

Improvement in spring grains for the Northwest.—Still further good results have been obtained during the year with the Swedish Select, Tobolsk, and Sixty-Day oats, varieties introduced from Russia in cooperation with the Office of Seed and Plant Introduction and Distribution, but which have been made better through acclimatization and selection. The Swedish Select is now the popular oat in Minnesota and Wisconsin and is by far the best of all varieties in those States. The Hanna barley, another Department introduction, after further trial is still giving excellent results. One of the most important grains for the Northwest, not mentioned in former reports, is the Russian proso or broom-corn millet. Several varieties of this grain, introduced by the Department five years ago, have, after thorough acclimatization and selection, proved to be among our most valuable introductions for stock food in the semiarid districts. Proso is now a well-established crop, at least in North Dakota and South Dakota. This millet, besides furnishing a large amount of hay (2 or 3 tons per acre), produced also from 25 to 40 bushels of seed per acre, which is the very best material for poultry feed, does exceedingly well for feeding to sheep and hogs, and is likely to be of value for dairy cattle. Even a very dry season does not prevent a good crop, and the quality of the grain is all the better because of drought.

GREATER DROUGHT RESISTANCE.—Further experiments with drought-resistant grains show that we can expect still greater resistance to drought on the part of a number of these varieties than they were supposed to possess. It is now evident that the belt throughout which these grains are adapted extends much farther west than hitherto indicated on the maps. This additional knowledge is brought out after further acclimatization of the varieties. Meantime other varieties have been introduced, some of which appear to be still more drought-resistant than those that were formerly obtained. Of still greater importance is the fact that among these recent introductions is one particular variety of common bread wheat from Trans-Caucasia which appears to be just as drought-resistant as are the best of the durum wheats.

WHEAT HYBRIDS.—The experiments with several hundred wheat hybrids have reached the fourth generation, and it is now possible to determine a number of the selected strains of these hybrids which will be worthy of fixation as valuable new varieties for certain purposes. However, it will probably require three years more to be able to grow these as stable varieties in large plats. Some of the important qualities that will be obtained in these new hybrids are (1) earliness in the hardy Russian winter wheats through crosses with early Japanese stocks; (2) tenacity of chaff in varieties like the Jones's Winter Fife by crossing with emmer, thus producing a wheat of the greatest value for the Pacific Northwest; (3) rust resistance in common bread wheats through crosses with the durum wheats and einkorn; (4) winter hardiness in the durum wheats through crosses with the hardiest Russian winter wheats; and (5) better quality of grain in both the hard spring wheats and the hard winter wheats through crosses with each other.

RUSTS OF GRAINS.—The investigations of cereal rusts, formerly carried on extensively, have been revived during the year. A large part of the work has been carried on in cooperation with the Indiana Experiment Station. A bulletin reporting the results obtained to date in the investigations of rusts, which have not been published since 1899, is now in press. These results include some facts that are of great economic importance concerning the rusts of several of the common grasses and grains.

CHEMICAL STUDIES OF GRAINS.—This line of work has been in the main a continuation of the experiments of the preceding year. A further study has been made of the durum wheat flours with reference to their value for bread making. A special series of experiments has also been made in the chemistry of the grain of different varieties of oats to determine particularly the comparative feeding value of new varieties recently introduced by the Department.

CEREAL DEMONSTRATION FARMS.—In the introduction or development of new varieties of grains a large part of the adaptation work is carried on at the State experiment stations. To obtain a better knowledge of the behavior of these grains over as large a portion of the country as possible, however, it has been found desirable to make trials of many of them with responsible farmers at various points on a much larger scale and in a more thorough way than in ordinary instances of the distribution of grains. These trial grounds may be called demonstration farms. A careful oversight is kept over these

experiments and the owners of the farms are expected to follow rigidly the instructions of the Department concerning time and method of seeding and further cultivation. Some of the most important of these demonstration farms up to date have been at the following points: Grant and Hough, in Nebraska; Kinsley, Coolidge, Enterprise, Waterloo, and Hoxie, in Kansas; Woodward and Arapaho, in Oklahoma; Temple, The Grove, Fort McKavett, Sherman, and Bigspring, in Texas; Forestburg and Hartford, in South Dakota; Glover, Lisbon, and Eldridge, in North Dakota; Brandon, in Wisconsin; Belt, in Montana; Idalia, Crestone, Lansing, and Vernon, in Colorado; Blackfoot, in Idaho; Colmor and Roswell, in New Mexico; Evansville, in Arkansas; Lagrange, in Georgia; and Wellborn, in Florida.

Grain cultivation methods in semiarid districts.—In many cases trials of new or improved grains have failed, not because of the failure of the varieties themselves, but because of very bad methods of cultivation, mistakes in the manner of seeding, etc. Moreover, it is particularly true in the semiarid districts that the method of cultivation is most important, and that proper cultivation and the proper rotation of crops accomplish perhaps more than anything else in the thorough establishment of field crops in those districts. Therefore it has been found advisable to carry on a thorough series of experiments in methods of cultivation and occasionally a few series of crop rotations in connection with the work at a number of the experiment stations where cooperative investigations are being made. These experiments have already furnished some most excellent results.

Cooperative work with the State stations on cereals.—A great deal of the experimental work with cereals has continued to be carried on in cooperation with the State experiment stations. Particularly valuable results have been obtained so far in Kansas and South Dakota. Two bulletins have been published by the South Dakota station giving some of the results of this work, which has been principally with oats, barley, and durum wheats. Results of special value have also been obtained in the cooperative work in Tennessee, and a publication of the results has been made on the part of the station. These results show especially the milling value of a number of the best varieties of wheat grown in Tennessee and that they compare very favorably in this respect with wheats grown in other parts of the country. Valuable work has also been accomplished in cooperation with the stations in Texas, Nebraska, Minnesota, North Dakota, Wisconsin, Iowa, Washington, and Maryland.

COOPERATIVE FIELD CROP IMPROVEMENT.

Work in Minnesota.—The investigations coming under this head have for their object the study of crop rotations and improvements and the adaptation and management of special crops in definite localities and agricultural sections. The work is carried out in accordance with plans formulated and agreed upon by the Department and experiment station officers, and thus the best and most effective methods of work are assured. Prof. W. M. Hays, of the Minnesota Agricultural Experiment Station, represents the Department as special agent in connection with this work and has greatly assisted in its development. The work at the Minnesota station, directed by Professor Hays, includes in the

plant-breeding nursery about 350,000 individual plants, most of which are pedigreed. These plants include select strains of most of the important crops adapted to Minnesota conditions. Besides the nursery work, there are about a thousand one-tenth-acre plats of variety tests. In this work special attention is given to a number of the most important crops, such as alfalfa, the object being to secure hardier sorts adapted to northern cultivation. Good results have been obtained in securing barleys producing heavier yields, brome-grass suitable for Minnesota and other northern localities, and red clover and Indian corn better adapted to the climatic and soil conditions of the Northwest. There has also been considerable work on the improvement of flax, improvement of millet, winter rye, timothy, field peas, and soy beans.

Work in Wisconsin.—The cooperative field crop improvement work in Wisconsin is in charge of Prof. R. A. Moore, agriculturist of the Wisconsin experiment station, who has been made a collaborator of the Department. The work includes the improvement of cereals, oats, barleys, soy beans, cowpeas, alfalfa, clover, rape, vetch, and other field crops. The Swedish Select oat, one of the varieties introduced by the Department, has been widely disseminated by the station. Not less than 200,000 bushels of this variety were harvested in 1903, and this quantity was largely used for seed.

Work in North Dakota.—The crop-improvement work at the North Dakota station is in charge of Prof. J. H. Shepperd, director of the station and a collaborator of the Department. In the season of 1903 the station grew 11,000 plants of wheat in the plant-breeding nursery, and directed its energies toward improving by selection the yield, grade, stiffness of straw, and rust resistance of the plants. Work of the same kind is under way on barley, of which there were 2,500 plants in the nurseries. There were also 4,400 flax plants, 1,500 buckwheat plants, 3,600 millet plants, and 4,352 plants of various legumes. All these plants were grown in the nurseries with the special object of making definite selections. As the value of the improved types becomes more pronounced the work of selection is carried on in such a way as to increase their numbers to the point where they will eventually be ready for distribution.

WORK IN PLANT PHYSIOLOGY.

The work of the Laboratory of Plant Physiology is under the immediate charge of Dr. George T. Moore. As in previous years, there have been but two main lines of work carried on, namely, (1) that concerned with the fixation of atmospheric nitrogen by bacteria and (2) an attempt to discover some efficient, practicable, and cheap means of eradicating algæ and similar organisms from reservoirs and other large bodies of water.

Nitrogen fixation investigations.—As the result of investigations carried on in this laboratory during the last three years and referred to in detail in previous reports, we have been able during the past six months to distribute in large quantities cultures of nodule-forming organisms to all parts of the United States. There have been distributed 7,315 cultures, which it is estimated have been used in inoculating 23,434 acres of land. At this time it is impossible to make

any comprehensive report upon the result of these inoculations, as comparatively few returns have been received. It is believed, however, that where the directions have been properly followed the results have been satisfactory, and in most of the cases which have been brought to our attention the advantages of inoculated over uninoculated ground have been very marked.

WATER PURIFICATION INVESTIGATIONS.—At the time of last year's report the reservoir of the Winchester (Ky.) waterworks was being experimented upon in order to determine the practical effect of the copper treatment in a badly polluted water supply. The experiment was a complete success, and a detailed report from Mr. Karl F. Kellerman has been submitted and is on file.

An artificial lake at Passaic, N. J., containing 26,000,000 gallons, was completely cleaned of Spirogyra and other filamentous forms of algæ. This was an artificial lake which had been constructed for the purpose of beautifying a new addition to the town; but on account of the growth of algæ the water was supposed to be unhealthful, and, instead of helping to sell the lots, the lake was a positive detriment. For this reason an expenditure of several thousand dollars in filling it up was seriously considered. Since the successful treatment by the Department, however, the lake is having the effect for which it was originally designed, and naturally the owners are very much pleased with the result. A report upon this experiment was submitted by Mr. T. Ralph Robinson and is now on file.

In May, 1904, a request was received from the president of the Jacob Tome Institute, at Port Deposit, Md., that we investigate the condition of the water in the reservoir owned by the school, in order that some line of treatment might be recommended which would make possible the use of this reservoir. Upon investigation it was found that the situation here was one particularly well suited to illustrate the inability of even the best water engineers to deal with pollutions caused by algæ. In this case, after the bad odor and taste in the water had appeared, the reservoir and sand filters were abandoned and the supply was taken directly from the springs. This, of course, was a very simple means of eliminating the source of the bad odor and taste in the supply, but unfortunately a few weeks later the spring water was polluted with typhoid, and since there was no storage reservoir and the sand filters had been abandoned, about fifty cases of this disease appeared in one week in the school. At the time the reservoir was examined by us it was found that the maximum growth of algæ had passed, and although the odor and taste were still very objectionable they could not have been as bad as earlier in the season. However, a treatment of 1 part of sulphate of copper to 1,000,000 parts of water was made, and two weeks later the president wrote as follows: "The improvement in the taste and odor of the reservoir has been extremely marked. * * * We are grateful for the very material assistance that you have given us."

Treatment has also been made at Stockbridge, Mass., and a large number of requests are on file, which will be taken up should the conditions warrant.

PATHOGENIC BACTERIA.—In addition to the effect of copper sulphate upon algæ, it was discovered that this salt might prove of considerable

value in temporarily sterilizing reservoirs polluted with typhoid and similar disease germs. The application of this discovery under certain conditions will prove to be of inestimable value. The fact that the cholera germ is slightly more susceptible to copper than typhoid has suggested the possibility of extending this method to the Tropics, and the necessity of using every method of sanitation in the Canal Zone makes it desirable that this treatment be thoroughly tested there.

It has also been found that certain species of mosquito larvæ are susceptible to copper sulphate at a dilution of 1 to 1,000,000, and it is hoped that eventually some method for their destruction may be devised which will be an improvement upon the kerosene-oil treatment.

WORK AT THE MISSISSIPPI VALLEY LABORATORY.

The work of the Mississippi Valley Laboratory during the past year has been conducted, under the immediate direction of Dr. Hermann von Schrenk, along similar lines to those of the year preceding. This work is proceeding along two lines—(1) a study of the diseases of fruit trees and timbers and (2) work in cooperation with the Bureau of Forestry on timber-preservation investigations. The following is a summary of the work carried on, together with an indication of the results obtained:

Red-rot of Louisiana pines.—A red decay is responsible for the destruction of many thousand feet of lumber of loblolly and shortleaf pine, particularly in the Southern States, every year. There has been a general impression that it is not possible to cut and stack timber for any length of time in the South without much loss because of this disease. Investigations carried on during the past year have shown that this trouble is due to a fungus which begins to grow in the wood shortly after it is cut from the tree. The fungus grows with great rapidity at all seasons of the year and attacks the wood of both logs and sawed lumber. A complete study of its life history was made both in the forest and in the laboratories of the Missouri Botanical Garden. At the same time large quantities of wood were cut at monthly intervals in southeastern Texas, where the timber was put up in various forms of piles to determine whether it would be possible to dry the wood with sufficient rapidity to prevent the growth of the fungus and at the same time to test the susceptibility to decay of timbers cut during different months. It has been determined that loblolly pine timber can be cut and piled under the worst conditions in Texas in such a way that it will be practically free from any fungus attack for twelve months. The investigations have already resulted in a modified system of handling this timber in Texas, and it is believed that a very large saving will be possible as a result of the work done.

Diseases of beech and maple in the Adirondacks.—A study was made during the last summer in New York State on a serious disease of the beech and maple due to a wood-rotting fungus. A proper understanding of the period when forest trees are first attacked by wood-rotting fungi is daily becoming more important in connection with lumbering operations. A definite series of data was obtained as to the ages and sizes of trees attacked by this disease and likewise the manner in which the fungus causing the trouble develops in the living tree.

CULTURE STUDY OF WOOD-DECAYING FUNGI.—The culture bed which was established two years ago at the Missouri Botanical Garden for testing the relative resisting powers of various species of timber, particularly when in the form of lumber, has been in successful operation. During the year a number of structural woods, commonly used in greenhouse and other building construction, have been placed in this bed for the purpose of determining their relative resistance to decay under the most severe conditions under which it is possible to place them. The fruiting bodies of a fungus which every year destroys thousands of dollars' worth of structural timber have been produced, and it is expected that during the coming year the physiological conditions favoring the development of the spores and threads of this fungus in buildings may be definitely determined.

THE BLUE DISEASE OF PINE.—Considerable progress was made during the year in continuance of the work toward determining a method of preventing the development of the fungus which causes the blue stain in pine timber, particularly in the Southern States. The loss incident to this trouble is increasing every year in the South. Arrangements have been completed for a careful series of tests with fungicides applied on a large scale in lumber yards.

BITTER-ROT.—The investigations as to the bitter-rot of apples have been brought to their conclusion for the present. A bulletin on the bitter-rot was published and distributed during the summer of 1903. In a good many orchards the recommendation for cutting out the cankers was followed, and it remains to be seen during the coming summer to what extent the removal of these centers of spore distribution has benefited the orchards.

CROWN-GALL.—One of the chief subjects under investigation during the past year was the crown-gall of the apple and other fruit trees. The following points were considered particularly:

(1) The infectious nature of the disease—that is, whether it is possible for the disease to be transmitted.

(2) The manner in which the disease spreads.

(3) The relation of infection to wounds.

(4) The relation of the development of crown-gall to the depth of planting.

(5) Varietal, specific, and generic predisposition.

(6) Whether the various forms of crown-gall are interchangeable in different species and genera of trees.

The investigations were carried on in the greenhouses at the Missouri Botanical Garden, on a 2-acre nursery plot near Louisiana, Mo., and on a similar tract near Bernalillo, N. Mex. Twenty thousand root grafts of 250 varieties of apples, 400 seedling apple trees, 200 2-year-old apple trees, 100 peach, 100 cherry, and 200 plum seedlings were grown out of doors. Some of these were inoculated by sowing minced apple galls in the rows, while a second lot was left as a control. In the greenhouses almond, peach, apple, pear, quince, apricot, walnut, grape, and chestnut seedlings were raised from seed under carefully managed conditions, and cuttings of rose and raspberry plants were grown. These plants were inoculated variously with galls from apple, pear, peach, almond, rose, plum, and raspberry plants.

It is pointed out that because of the character of the disease it will take several years of consecutive work to reach any definite conclu-

sions. As a result of last year's work the following general results may be noted:

(1) Apple crown-gall is infectious on the apple and pear only through wounds, but is certainly not infectious upon the peach, plum, cherry, almond, apricot, rose, walnut, chestnut, and raspberry. Certain varieties of apples are more resistant than others to the disease. The depth of planting has little effect upon the development of the disease.

(2) The crown-galls of the peach, almond, plum, apricot, walnut, and chestnut, and possibly those of the hop and raspberry, are presumably due to one and the same cause.

(3) The rose crown-gall is at least not readily infectious and appears to be propagated chiefly through diseased cuttings.

In certain vineyards in New Mexico the grape crown-gall disease is growing to be a serious trouble. A 3-year-old vineyard at Bernalillo, N. Mex., was selected for treatment. Nearly all the vines in this vineyard were diseased at the beginning of the experiment. A portion of the vines has been treated with formalin, and others with copper sulphate and several other fungicides. A large part of the vineyard has been replanted with 10 varieties of wine and table grapes for the purpose of securing data as to the infectious nature of the disease and determining methods of treatment. A good deal of correspondence has been carried on during the year with reference to this disease, which, because of its wide geographical distribution, is every year becoming a more serious menace to a larger number of orchard trees. The experimental tract in Louisiana has been enlarged, and during the coming year the work will be carried out on an increased scale.

Fence-post investigations.—In cooperation with the Bureau of Forestry, investigations were started in the spring of this year with a view to determining a simple method for treating fence posts so as to increase their length of service. Various short-lived and otherwise valueless woods have been cut and will be treated during the coming summer. A small apparatus, costing only about $40 or $50, has been devised, which will be used for treating these posts with tar oil. Owing to the enormous consumption of posts, particularly in the Western States, it is believed that some cheap method for treating posts would result in great benefit to farmers.

STUDIES OF PLANT LIFE HISTORY.

The Laboratory of Plant Life History, under the immediate charge of Mr. Walter T. Swingle, was established during the present year. Its establishment is the outcome of investigations which Mr. Swingle has conducted for some years past, and this new line of research promises results of such great practical as well as scientific value that a considerable extension of it appears highly desirable.

Plant life history investigations have for their object the determination of the exact climate, soil, and cultural requirements and limitations of important crop plants. Such work is of fundamental importance in determining not only the best methods of culture of crop plants and the special treatment which they need in order to succeed in any given locality, but also the direction in which the capabilities of these plants can be most advantageously modified by the plant breeder.

When once the environmental requirements and limitations of a crop plant are known and this knowledge is given concrete and practical expression, the prospective planter can have a definite idea of the needs of that crop and will be able to decide intelligently whether his particular location is suited for its cultivation. Such information will tend to prevent unfortunate booms of new cultures in localities where they are precarious as well as hasty, and unjustified condemnation of new and little-known cultures, which so often occur when the growers are in ignorance as to the needs of the plant under trial.

Life history study of the date palm.—As an instance of the importance of a complete life history investigation it may be remarked of the date palm that although extremely resistant to alkali it is at the same time exceedingly intolerant of insufficient drainage.

In the case of the date palm it has been possible to establish a new industry by means of demonstration cultures and to give intending planters definite advice as to the selection of varieties, which otherwise could only have been secured as the result of most costly tests. With a plant like the date palm such tests would involve five or ten years' waiting before definite results could be available, and this would, perhaps, have delayed the introduction of this most profitable fruit culture indefinitely.

The practical introduction of the date palm, which has gone along hand in hand with this life history study, has been carried forward by the Office of Seed and Plant Introduction and Distribution in the closest cooperation with these investigations, and as a result two cooperative date gardens have been established in the most promising localities in this country, where it will be possible to bring all the varieties practicable from the Old World into perfect fruiting. Already marketable dates are being produced within our borders and private growers are undertaking date culture in steadily increasing numbers.

Life history of the pistache.—Another life-history investigation which has been brought to a close during the fiscal year is that of the pistache nut. The investigation of this plant has shown that it is remarkably well adapted for cultivation in many parts of California and Arizona, where other nut and fruit plants often suffer because of extreme conditions which are really required by this remarkable plant. One of the chief advantages of the culture of the pistache nut in the Southwest is its tardy awakening in the spring. The flowers appear about a month later than on the almond, and usually after all danger of late spring frosts is past. Another and very important outcome of this study is the discovery that this plant can be grafted on certain very drought-resistant stocks which grow in the deserts of the Old World. These wild species of pistache are the only plants which reach the size of a large tree in the deserts of Sahara and south central Asia, and it is believed that by their use pistache culture can be introduced into hundreds of square miles of land too dry for other crops.

Nearly one-fourth of the area of the United States is popularly condemned to perpetual aridity or semiaridity, yet it is no exaggeration to say that had the settlers in the Middle West come from the drier parts of the Mediterranean region instead of from humid regions much of the land now classed as hopelessly arid would be covered with profitable crops. Scientific agriculture should be able to lead to the rapid subjugation and exploitation of a strip of the richest lands in

America, from 200 to 400 miles wide, running from North Dakota to Texas.

It is therefore the purpose to inaugurate a special line of investigation in the Laboratory of Plant Life History, bearing on the establishment of profitable agriculture in the semiarid zone and on the economy of water in irrigated regions, in both cases through a thorough knowledge of the requirements of the crop plants in question.

INVESTIGATIONS ON CHANGE OF SEED.—The Laboratory of Plant Life History has also undertaken, in connection with the Seed Laboratory of this Department, to investigate the much-mooted question of the advantages of change of seed from one region to another. This problem is now being worked out with red clover. It is the object of this investigation to settle beyond all doubt whether or not change of seed is essential or desirable for the proper production of a crop of clover in any region. It is necessary to carry on such an investigation with the greatest possible care, to avoid drawing mistaken conclusions from other interfering conditions. For this reason it was practically impossible to settle this question until the methods of plant life history study had been brought to their present perfection, so that disturbing conditions could be eliminated and the experiments made to answer definitely the question whether or not change of seed is desirable or necessary.

In connection with this investigation of the benefits of change of seed it is proposed to study the remarkable phenomena which have been observed in connection with the planting of northern-grown seed in southern localities. Such seed, it is generally believed, gives earlier maturing crops than seed of the same variety grown farther south. It is proposed in this connection to test Linsser's interesting conclusion, namely, that the sum of heat required to mature any plant is a certain percentage of the total heat of the region where it grows, and that consequently the same plant grown in a northern region comes to adapt itself to a smaller total sum of heat than a plant grown in a southern latitude.

The experiments now being conducted on red clover promise, therefore, to yield results of great scientific as well as practical value.

WORK OF THE SUBTROPICAL LABORATORY AND GARDEN.

The Subtropical Laboratory is in charge of Mr. P. H. Rolfs and is located at Miami, Fla. This laboratory is the headquarters for our work in Florida and the Gulf States of that region. The facilities of the garden enable us to handle and propagate many tropical and subtropical plants which could not be handled otherwise, except under glass. We have growing at the garden approximately 2,400 hybrids of Citrus, including 200 hybrids of *Citrus trifoliata* crossed with different forms of sweet oranges. These hybrids are being grown for the Plant-Breeding Laboratory.

Three hundred and twelve different pineapple hybrids, mostly in the second generation, are also growing in the garden.

A number of species of rubber plants have been tested and several of them have made rapid and healthy growth. Some of the plants are now large enough to be tapped for rubber.

Annatto dye plants are growing luxuriantly and producing an abundance of seed, from which the dyeing material is made. The success of

these plants shows that this dye, which is now largely imported, can be produced at home.

The Office of Seed and Plant Introduction and Distribution has placed at the laboratory 31 varieties of cassava. Some of these originated near the snow lines of the Andes Mountains, and are therefore quite hardy. They are being distributed for testing in Texas, Mississippi, and Florida. The cassava produces more hog and cattle feed per acre than is contained in the same area of the best corn grown in the Northwest. Cassava will grow on poorer soil and with much less fertilizer than any other forage crop of the same type that could be raised in the section of the South adapted to its cultivation.

Some very valuable grafted varieties of mango from India are growing luxuriantly in the garden. A number of them will soon be budded and ready for distribution in Florida, Porto Rico, and Hawaii. The Insular Bureau of Agriculture has sent to this garden bud wood from a famous Philippine seedless mango, and buds of this mango are now growing in the garden. A method of budding alligator pears has been successfully worked out, and it will now be possible to propagate the very best varieties.

Diseases of citrous fruits.—Several of the most serious diseases of citrous fruits are under investigation in the Subtropical Laboratory. Mr. Rolfs completed his work on the wither-tip diseases, which are quite generally distributed and cause a loss of from 10 to 50 per cent in many cases. Successful methods of preventing the loss from these diseases have been worked out, and a bulletin discussing the matter in full has been issued.

Investigations of the disease known as "blight" have been continued throughout the year both in the laboratory and in the field. This disease, while very prevalent and exceedingly destructive, is now well understood. It seems to be most destructive among trees over 20 years old. In some orchards of this age as high as 30 per cent of the trees have been found to be affected or destroyed.

The dropping and splitting of citrous fruits has received considerable attention, and it has been found that one of the most common causes is overstimulation with highly ammoniated fertilizers, causing the trees to approach a condition known as "die-back." While the trees themselves may not show signs of the trouble, the fruit indicates its presence by splitting or dropping. It is a peculiar fact that this form of dropping and splitting can be helped by early spraying with Bordeaux mixture. Two or three sprayings before the fruit attains half size will very materially lessen dropping and splitting. In groves affected by wither-tip there is also considerable dropping of fruit, which can be prevented by spraying.

Florida truck-crop diseases.—The rapid development of truck-crop interests below the frost line in Florida has made it necessary to assist the growers to overcome a number of serious diseases. One of the worst of these is tomato wilt. The cause of this disease is well known, and considerable progress has been made in selecting resistant strains. Considerable work was also done on potato diseases and upon diseases of the pineapple. Abortive pineapple fruits, or the so-called "culls," have been found to be due largely to sudden drops in temperature during the blooming period, causing many of the flowers to fail in development.

WORK AT THE PACIFIC COAST LABORATORY AND PLANT-IMPROVEMENT GARDENS.

Work at the Pacific Coast Laboratory, in charge of Mr. Newton B. Pierce, has broadened and developed materially during the year. As usual, the correspondence and routine work of the laboratory have been heavy.

PATHOLOGICAL INVESTIGATIONS.—The laboratory and field investigations of a pathological nature have covered the usual wide range of diseases of plants of both temperate and semitropical requirements. The examination of diseased plants submitted for recommendations has taken considerable time, but the main pathological work of the year has been in relation to walnut bacteriosis and the California vine disease—two of the more serious plant diseases of the Coast.

Walnuts.—In the spring of 1903, spraying experiments were conducted with the object of determining whether the two sprayings recommended for the control of walnut bacteriosis were essential or whether one treatment would accomplish the saving heretofore obtained by two treatments. It was learned that the second spraying, given as soon as the nuts are firmly set, is necessary to success. Knowing the beneficial action of Bordeaux mixture upon the blight, as determined by the laboratory in the experiments of previous years, numerous growers have tested this fungicide both in liquid and in powdered form. It has thus been shown by growers working independently of the Department that two treatments with this mixture will prevent 50 per cent of the loss from the disease, which confirms the results secured by the Department.

The hybridizing work upon walnuts is progressing, and new light has been gathered tending to improve former methods. The objects of this hybridizing are, as stated in former reports, the production of immune trees, as only *Juglans regia* is found susceptible to the blight. All known species of Juglans so far obtained are being used in this work, and the collection of species of this genus is becoming quite complete. The work on walnut bacteriosis is now sufficiently advanced to warrant the publication of a report upon its nature and treatment, and it is hoped that time for the preparation of such a report may be found during the ensuing year.

Grapes.—The past year has sustained the deductions drawn in the previous year's report relative to the resistance to the California vine disease of the vines the laboratory is testing. Positive proof is now in hand that the variety to which the greatest hardiness has been assigned, the Lenoir, is almost absolutely resistant to this disease when growing upon its own roots. One vineyard within the infected district has now grown for twenty years, another for sixteen, and a third for nine years, and all of them are in a thrifty condition and loaded with fruit. This is in spite of the fact that these vineyards were surrounded by other varieties which long since died of this disease. At the time of writing it is too early to note the action of the disease on the experimental grafted vineyards for the summer of 1904, but it may be said that a careful examination of the vines in the extensive experiments made in the autumn of 1903 showed that when discretion was used in

the selection of a comparatively hardy variety to work on the Lenoir root the results were wholly satisfactory. A large block of Feher Zagos vines on Lenoir roots showed absolutely no signs of disease. Of the more tender varieties on the same root, evidences of the trouble were apparent in the foliage and canes, but none of the tops had died of this disease in the heat of the season, as is usual with the malady. It is therefore evident that comparatively hardy vines may be successfully grown on the Lenoir root in the face of the California vine disease, and that the life of more tender types when used as top grafts will be materially prolonged through the hardiness of this root.

In addition to the 400-acre grafting experiment in progress in northern California, stocks for like work in the southern part of the State have been procured and planted during the year. Numerous local experiments in the most seriously infected districts will then become possible. During the present spring, hybridizations between the Lenoir grape and other well-known and valuable varieties have been made, many thousands of buds being crossed. By this work it is purposed to develop ultimately a strain of grapes possessing much of the resisting qualities of the Lenoir, yet retaining various desirable characteristics of the other parent varieties. This phase of the work will be continued from season to season until a large group of this class of hybrids is obtained. It may also be reported that a considerable collection of wild species of Vitis has been made during the year, to be used in this and other vine-breeding work. It is hoped ultimately to make the plant-improvement gardens one of the most complete vine-breeding stations in the world.

Tomatoes.—The winter production of tomatoes in California has attracted the attention of enterprising growers, but it was found that the plants frequently blackened and died. The trouble was supposed by growers to be the bacterial blight of the Eastern States. Good material for study having been received during the present spring, it was readily determined that *Phytophthora infestans* and not a bacterium is the cause. The disease may now be successfully prevented with fungicides.

Pear-blight.—Pear-blight has developed extensively in the Sacramento Valley during the year, as has been carefully determined by laboratory work. Such recommendations for its control as seemed most practical have been broadly disseminated through the newly infected region by means of the press and otherwise.

Plant-improvement gardens.—The founding of these gardens was announced in last year's report. During the present year the opportunities offered along lines of wild-plant improvement have become more and more manifest, and it may be said with confidence that the practical returns from this line of work will equal those of any branch of the Department for the necessary outlay required. During the period of less than two years since the gardens were established the types of plants received already exceed 2,000. Many of these plants are new to the United States, but are locally known in their habitats as valuable fruit-bearing shrubs or trees, valuable for timber, for dyes, in the arts or in medicine, as honey producers, starch producers, for tanning properties, as forage crops, as grains, or for the possession of one or more of the many other qualities useful or pleasing to man.

Among these many wild types may be found those well adapted as stocks for economic forms already under cultivation.

As is generally known, the hardier plants are usually found in a state of nature, growing wild; hence the collection and study of these wild types lies at the foundation of any breeding work looking to the conquest of plant diseases by Nature's laws. This work therefore lies at the very root and represents the essence of modern pathological methods. It is thus purposed to develop these gardens and their collections of wild types in such a manner and along such lines that they shall afford unexcelled facilities for the overcoming of plant diseases, as well as with the view of improving the wild types themselves. During the year about 150 species and varieties of Ribes have been added to the collection, and in other genera and families equally or even more valuable collections have been secured. Among these plants are several wild forms offering every prospect of being the forerunners of new industries for the country. As most of the wild plants are secured in the form of seed, the danger of importing new diseases or insect pests is largely eliminated.

The facilities for the germination of seeds and the growth of seedlings have been much improved at the gardens during the year, but additional hothouse facilities are much needed. Congress made provision for this necessity during the past session, and it is hoped to have the building ready for use by fall. It is purposed to erect a building suited both for general hothouse work and for experimental pathological investigations. Several such investigations have been impracticable in the past, owing to the lack of suitable hothouse facilities.

A few of the lines of plant-improvement work already inaugurated at the gardens may be named.

Lilies.—Thousands of seedling hybrid Bermuda lilies (*Lilium longiflorum* Thunb.) are being grown, and seeds from plants free from the "Bermuda lily disease" selected. The seeds have been grown and furnished to the laboratory by Mr. George W. Oliver, of the Office of Seed and Plant Introduction and Distribution. The selection work has already demonstrated the practicability of commercial lily culture in California. The gardens have brought to bloom, from seed, over 2,000 lily plants in 20 months, and many of these have developed from 12 to 20 flowers each with no fertilization of the soil.

The pepino.—Mr. E. A. Metcalfe, in charge of Garden A, has for more than a year been conducting hybridizing work with the pepino and other species of Solanum. It is thought that many now useless species of the genus may be made of value.

Walnuts.—Hybridizing work is in progress, looking to the transmission of sufficient cold-resisting qualities to the English walnut to permit of its culture as far north as Canada. Similar work is in hand for the production of improved pedigreed types of this nut for semitropical climates.

Cherries, chestnuts, currants, etc.—Fruit and nut plants of these classes frequently fail to bear in semitropical climates, and efforts are now being made to produce forms fruitful under these conditions.

MUSHROOM INVESTIGATIONS.

During the past year the mushroom investigations carried on by Dr. B. M. Duggar, of the University of Missouri, have been continued along lines previously indicated, and the practical outcome of the work with *Agaricus campestris* has already been felt. For this reason special prominence has again been given to the work with this species.

The experiments in making mushroom spawn were thoroughly successful. In the hands of experienced growers, as well as in the experiments at Columbia, Mo., this spawn has given excellent results. With amateurs it has also been more uniformly successful than the imported spawn. Encouraged by their tests of pure-culture spawn during the previous season, several growers have undertaken to make, by the methods recommended by the Department, a home-grown spawn on a considerable scale for the American market.

The characteristics of the more important varieties of *Agaricus campestris* have been studied, and a differentiation of at least three varieties, in a horticultural sense, has been for the present suggested. Pure cultures of prolific strains of three varieties have been furnished several growers. Nutrition studies have been continued, both by means of laboratory cultures and by fertilizer tests applied to the mushroom beds.

Brick spawn has also been made of *Agaricus subrufescens* and of a closely related species, both of which fungi promise to do well under conditions somewhat different from those required by *Agaricus campestris*. The cultivation of the larger species of puffballs has been attempted as yet only in a preliminary way. It has been shown beyond a doubt, however, that the "tissue-culture" method of obtaining pure cultures is readily applicable to nearly all fleshy fungi. Cultures of a number of edible mushrooms have thus been accumulated, and the most promising of these will be tested practically. Special mention should be made of cultures of the morel (*Morchella esculenta*), a fungus which in flavor and in market value rivals the truffle.

Numerous inquiries relating to mushroom growing have been received from all parts of the country, and these have been given careful attention. A Farmers' Bulletin dealing with the general question of mushroom growing has been prepared.

HERBARIUM.

Several valuable and rare sets of exsiccati have been secured for the Herbarium during the year. The collections have been materially increased by the purchase of fascicles of current exsiccati and by the cooperation of collectors, both American and foreign, by means of our mycological exchange. The Herbarium has greatly outgrown its accommodations, and its proper care renders imperative the prompt purchase of insect-proof cases. In the laboratory connected with the Herbarium considerable attention is always given to the examination of material for agricultural experiment stations, whose equipment for identifications is often limited. Much time is also spent in research work along bibliographical lines and in looking up the geographical range of fungi, especially of those producing diseases of economic importance. Identifications of the specimens sent by foreign col-

lectors are always cheerfully made, and many specimens are added to the Herbarium as a result. Special investigations and cultures have been made of certain molds occurring on grains and feeds, and an organism pathogenic to animals and man was isolated by means of thermostat experiments. The infected grain was subjected to various kinds of treatments, both chemical and physical, and a method finally discovered whereby such grain may be cheaply and easily rendered harmless. A series of investigations connected with the molds affecting citrous fruits is now under way, in cooperation with the pomologists of the Bureau. These questions bear upon the influence of refrigeration in retarding the development of diseases and upon methods followed in packing houses and in the handling of fruit in the groves. In addition to the mycological index, a systematic review of current literature is made, foreign and American, and an up-to-date working index kept of new and important economic species.

PLANS FOR FUTURE WORK.

The technical laboratory work in pathology will be continued along the same lines as formerly. The demands made upon the technical laboratories are constantly increasing, and the facilities for work have to be proportionately increased. The work on the gum disease of sugar cane will probably be completed, and considerable progress will be made in the study of the bud-rot of the cocoanut palm.

The work on the bacterial disease of carnations will be completed, and the investigation of a number of other bacterial and fungous diseases of crops will be pushed through as rapidly as possible.

In the sugar-beet work, demonstration experiments in different sections will be carried on, to secure the adoption by growers of the method of spraying with Bordeaux mixture for preventing the leaf-spot diseases, and selections will be continued with the hope of obtaining strains resistant to curly-top.

The single-germ seed ball selections will also be continued, and this line of work will be enlarged if the progress made during the present season justifies the continuance of the selection work. A large number of beet varieties will be tested during the present season, and it is hoped some hybrids can be secured which will have a tendency to produce single-germ seed balls.

In the work on orchard diseases the demonstration experiments for the control of pear-blight will be continued, as will also the eradication method of preventing little-peach. Attempts will also be made to find the cause of the trouble, if possible.

Special attention will be given to the brown rot of stone fruits in the Southwest. This is the worst disease of peaches and plums with which the grower has to contend. Extensive field experiments will be carried out during the season, with a view to a thorough testing of various spraying solutions under new and improved conditions.

The work of selecting wilt-resistant Upland cottons and of improving the varieties of wilt-resistant cowpeas will be continued; and the improvement of the wilt-resistant watermelons will be carried out in a number of sections.

Considerable work will also be done on pecan diseases, and a special attempt will be made to demonstrate the methods of preventing cucumber mildew by spraying, and of preventing some of the most serious potato diseases in the South and West.

A general survey of the trucking sections of the South Atlantic Coast is planned, and in this connection special attention will be given to the study of root diseases caused by nematodes. In the Southwest, work will be continued on the root-rot of cotton. Much of this work, however, will be carried on with the funds appropriated in connection with the boll weevil.

The work on cranberry diseases will be continued, special attention being given to spraying methods.

The work of the Plant-Breeding Laboratory will be continued, largely along the lines already under way. The long-staple cotton hybrids and selections will be grown and selected to fixed types, and propagated for distribution as soon as their fixity and improvement will justify. Several of the new races will probably be distributed to experiment stations and a few selected growers next year, in order to have them tested in different regions prior to their general introduction. The breeding and adaptation of Egyptian varieties will be extended as rapidly as possible, and every means used to induce buyers and manufacturers to recognize the good quality and value of the American-grown product. It is planned to have several of the select strains grown next year in large acreage under the supervision of agents of the Department, in order to secure quantities of the fiber sufficiently large to be handled by manufacturers without loss. If the results of the present season are encouraging, two of the selected strains will be distributed to a limited number of growers for preliminary trial. The breeding of early short-season varieties and varieties resistant to the boll weevil will receive special attention, and pedigree seed of early strains will be produced for the use of the planters in boll-weevil sections.

The investigations in the breeding of corn will be continued, and pedigree seed of some of the improved strains will be distributed for further testing. It is of special importance to secure better varieties for southern conditions, and this work will be somewhat extended. The experiments started last year in the production of better and sweeter canning varieties of sweet corn will be continued.

The five new varieties of citrous fruits which have been produced will be distributed this autumn, and the testing of those plants which have not yet fruited will be continued.

The work on the improvement of the oat will be continued, particularly with reference to securing hardy winter sorts for the South, more productive sorts for the Mississippi Valley States, and sorts specially adapted to the manufacture of cereal foods. The efforts, in cooperation with the State experiment stations, looking to the production of smut-resistant types will be continued along the same lines as last year.

The tobacco-breeding investigations, started last year in a preliminary way in Connecticut, have already given very promising results and will be continued and enlarged. It is important that the old Connecticut Broadleaf tobacco be improved and adapted to shade culture, and experiments with this in view will be inaugurated. The shade growing of tobacco has assumed important proportions in Florida, and the Sumatra type, which is principally cultivated, being found to lack seriously uniformity of type, shape of leaf, and quality, it is planned to inaugurate experiments in the production of an improved type which will better suit the Florida conditions and give a more satisfactory product. The crossing of hardy thoroughly acclimatized native varie-

ties with the imported types of better quality bids fair to yield improved varieties combining the desirable qualities of both parents, and the work in this direction will be continued and enlarged. At the present time it is impossible for tobacco growers to obtain good seed, and it is highly important that the Department should produce high-quality pedigree seed of uniform type as early as possible.

The investigation of crops in their relation to alkali soils will be continued, chiefly along the line of securing, by breeding, resistant strains of some of the more important field crops, notably alfalfa, wheat, barley, oats, and sugar beets. Imported seed of valuable races that are grown in parts of Asia and Africa will be largely used in this work, as heretofore. Laboratory experiments on the effect of the different salts found in alkali soils upon various crop plants will be carried on, as such experiments have been found to throw much light upon the numerous problems that arise in connection with actual field work.

In the Cereal Laboratory special attention will be given to the improvement of winter wheats and the development of winter grains for the South. The work on durum wheat, so far as its general introduction and establishment as a crop is involved, is now completed, and the further investigations along this line will be directed toward the improvement and better adaptation of the best strains to different sections. Special attention will be given to the improvement of spring grains for the Northwest, with a view to obtaining varieties more drought-resistant for sections beyond the one hundredth meridian, and a special study will be made of the rusts of economic grasses and cereals. The cereal demonstration farm work will be continued and considerable attention will be given to the methods of cultivating grain in the semiarid districts. The cooperative work with the State stations along these various lines will also be continued.

In the Laboratory of Plant Physiology we expect to have ready for distribution the nitrogen-fixing bacteria for nearly fifty kinds of legumes. We shall then have cultures of all organisms for which there has been any demand, as well as those that may be needed to treat new imported leguminous crops. It is hoped to make some further improvements in the methods of distributing these bacteria, though the cost has now been reduced to about 1 cent per acre and the labor involved on the part of the farmer is practically nothing. Facilities will be arranged, if possible, for meeting the very rapidly increasing demand for these bacteria. If possible, certain strains of these bacteria will be developed for use in the Far West, especially in California. Investigations of organisms which fix atmospheric nitrogen independent of any crop will be continued, and, in view of the information and cultures secured abroad, particularly in Russia, it is hoped that some practical results may be obtained. This is a most promising line of work and will be investigated as thoroughly as facilities will permit.

It is believed that the time has come for the inauguration of a line of bacteriological work distinct from the question of nitrogen fixation. As has been known for some time, the bacteriology of the soil is calculated to throw considerable light upon questions of nutrition, the crop-producing power of the soil, etc., and for this reason it is desirable that all information in regard to the bacterial life in soil be obtained. This line of work has been started in connection with an unusually satisfactory lot of soil samples.

Cultures of a very efficient flax-retting organism were secured in Russia and Belgium. It is hoped to undertake some work with these organisms the coming season.

In connection with the water-supply work, a number of demonstration tests will be made of our method of preventing the algal contamination of reservoirs. One of the most notable cases of a water supply polluted by algæ is that of Springfield, Mass. The Ludlow reservoir, with a capacity of about 2,000,000,000 gallons, has for the last fifteen years annually given trouble on account of the large growths of Anabæna and other organisms which appeared during the warmer months of the year. Every possible means of relief has been tried, including emptying the reservoir and constructing experimental filtration plants. Last year a special commission of water engineers, after carrying on extensive experiments and expending about $40,000, recommended that the present supply be abandoned and that an entirely new system be inaugurated. This would of course necessitate the loss of the present plant, valued at about $2,500,000, and it is probable that the installation of the new supply would cost in the neighborhood of $2,000,000. On account of the widespread interest in the recommendations of this special commission (it having received extensive notice in all the engineering journals of the country), it seems that the Springfield supply offers the most favorable opportunity that could be desired for testing the new method. The local water board is strongly in favor of this test, and as soon as authority is received from the State board of health, arrangements will be made for carrying out the experiment. This probably will not be undertaken until after the 1st of July, but it is hoped that the results will be sufficiently definite to enable the authorities connected with other supplies throughout the State to realize the efficiency of the copper treatment.

It is impossible to give at this time a list of all those reservoirs which will probably be experimented with during the coming season, but there is every evidence that we shall have all and more than can be attended to. There is at present being conducted by Mr. Kellerman, at Coldspring Harbor, N. Y., a series of experiments to determine the precise killing point of various solutions of copper upon trout and other delicate fish. This has seemed desirable because, while there is not usually much difficulty about fish in large reservoirs, there is some demand for advice in cleaning up small pleasure lakes and fish ponds where it is necessary to know accurately how strong a solution may be used. The reservoir at Butte, Mont., offers a particularly favorable field for experiment, and several reservoirs in Pennsylvania will be treated as soon as the conditions are right.

At the Mississippi Valley Laboratory the cooperative work with the Bureau of Forestry on methods of preventing diseases of forest trees and rots of construction timber will be continued. Special attention will be given to the development of a simple and cheap method of treating fence posts to prevent decay. Among the fruit-tree diseases special attention will be given to crown-gall, and it is hoped practically to complete the work on this group during the coming season.

At the Subtropical Laboratory the work of testing and propagating subtropical fruits for seed and plant introduction will be continued, and further investigation of diseases of citrous fruits and of truck crops grown in southern Florida will be made.

The work of the Laboratory of Plant Life History will be developed especially along the lines of "dry-land agriculture," as discussed earlier in this report.

The work at the Pacific Coast Laboratory will be carried on along practically the same lines as heretofore. Special attention will be given to the development of the plant-improvement gardens in connection with the laboratory, and especially to the cultivation, breeding, selection, and general improvement of useful wild plants. A very large and valuable collection of various fruits, nuts, berries, and ornamental plants is now under cultivation in these gardens and is being constantly increased. The results of the work so far accomplished on the walnut disease will be brought together for publication during the coming season, and, if possible, bulletins discussing other important diseases of crops on the Pacific Coast will be issued.

The mushroom work will be continued on the same lines as heretofore.

BOTANICAL INVESTIGATIONS AND EXPERIMENTS.

The Office of Botanical Investigations and Experiments has continued its work along much the same lines as set forth in our last report. The Botanist, Mr. Frederick V. Coville, has given personal attention to the collecting of data for a report on various systems for the granting of grazing privileges, through lease or permit, on large areas of arid lands. This inquiry was begun upon the request of the Public Land Commission for the purpose of ascertaining whether any of the systems now in operation give promise of successful application to the non-irrigable arid public lands of the Western States. The inquiry has been continued into the current fiscal year.

The tests of varieties of lettuce, repeated with increasing precision for several years past by Mr. W. W. Tracy, jr., under direct charge of the Botanist, have been brought to a close and the results prepared for publication.

The Economic Herbarium, under the care of Mr. W. F. Wight, is acquiring a fund of taxonomic information regarding agricultural plants which is in constant use for reference by our various botanical research workers.

The more fully organized branches of the office have been engaged upon botanical investigations as follows:

TROPICAL AGRICULTURE.

Field work.—The plans for the field work in tropical agriculture for the fiscal year 1904 were considerably modified in the interest of the Department's cotton investigations by sending a second expedition to Guatemala in the hope of finding a variety of cotton resistant to the boll weevil. The effort resulted in the discovery by Mr. O. F. Cook, who has this work in charge, of the kelep, or weevil-eating ant, numerous colonies of which were procured for introduction into Texas. This has been more fully discussed under the head of special work on cotton. Attention was given at the same time to the Guatemalan varieties of cotton and the natural conditions and methods of cultivating and utilizing this crop in that country.

Coffee culture.—The celebrated Cuban coffee district of eastern Guatemala was studied with special reference to the effects of diverse soils and climates. Definite evidence was obtained that the adverse

conditions which planters commonly try to correct by the use of shade trees are located in the soil and that even leguminous shade trees are not beneficial unless there is an adequate and permanent supply of soil moisture, to the retention of which present cultural methods are often not adapted. Observations of the structure, habits, and methods of growth of the coffee tree show that there are two entirely distinct kinds of branches, the diversity of which is overlooked in the current theories of pruning. Many mutations or spontaneous degenerative variations of the coffee tree were found in Guatemala, and it was also ascertained that these abnormal and unproductive trees are often far more numerous than hitherto supposed, so that it is a matter of distinct practical importance for the planter to recognize and remove them. A report describing and illustrating the principal types of coffee mutations is in preparation.

Jamaica has been visited by Mr. G. N. Collins in the interest of investigations on the culture of coffee, cacao, and tropical fruits. A study of the culture of the coffee tree of the Blue Mountain region of Jamaica, where the highest grade of coffee of the Western Hemisphere is produced, shows that it will be possible to secure for coffee culture in Porto Rico some of the many factors which combine to produce this high-grade coffee.

Cacao culture.—The condition of the cacao industry of Jamaica has been studied, with the result that the suitability of this culture to Porto Rico seems assured. It was found that the different varieties of cacao are so generally distributed over the island that a uniform sample is seldom secured. As a mixed sample brings a very much lower price, it becomes of prime importance in starting large plantations to procure pure seed of the best varieties. The leading cacao importers and manufacturers of the United States have been visited and an extensive series of samples secured with a view of ascertaining the requirements of the trade and the qualities and sources of the highest grades for introduction into our tropical possessions.

A survey of the banana industry of Jamaica, where bananas are profitably grown on steep hillsides, indicates the possibility of the utilization of similar lands in Porto Rico for this culture. The preparation of a publication on the avocado, a salad fruit, has been completed.

POISONOUS PLANT INVESTIGATIONS.

From the beginning of the fiscal year until January, 1904, Mr. Victor K. Chesnut was in charge of Poisonous Plant Investigations. At that time Mr. Chesnut resigned and the work was placed in charge of Dr. Rodney H. True.

Camas and larkspur poisoning.—During the earlier half of the year the attention of Mr. Chesnut was devoted almost exclusively to field investigations, carried on chiefly in the State of Montana. The poisonous action of death camas and larkspur was studied in continuation of earlier investigations on the same subject, and an effort was made to learn the nature of the active constituents and to work out some more practicable means for antidoting these poisons. Valuable results were obtained, which will be of practical assistance to herders in cases of sheep poisoning from the above-mentioned causes. The

active principles may be in great part destroyed in the stomach by the use of potassium permanganate in combination with aluminum sulphate. In case absorption into the blood has taken place the elimination of the poison must be hastened. Means of stimulating the excretory functions are now being studied.

Loco.—Mr. Chesnut, in connection with Dr. H. T. Marshall, made a study of the disease known as "loco," seen in several Montana bands of sheep. As a result of the inspection of the diseased animals and of experiments on sound sheep, the conclusion was reached that in addition to any effect which might be produced by the loco plants animal parasites played a very important part by infecting bands said to be suffering from loco. The question still remained as to whether the so-called loco plants really contributed to the trouble. Accordingly, during the past spring a number of sheep and lambs were purchased in a region free from the loco trouble and shipped to a location in which the disease was prevalent. These feeding experiments are still in progress and the hope is entertained that it may be possible to ascertain how far the loco weeds are responsible for the damage wrought. In any case, it seems probable that the so-called loco disease in sheep in Montana is of a composite nature, and that a large percentage of the cases, being in reality caused by worm parasites, are either preventable or respond readily to proper treatment.

General investigations.—In connection with a trip through the stock-raising regions of the West made in the spring, Doctor True visited Nevada at the request of citizens of the State and learned that in the western part of the State there is much loss, especially to sheepmen, from causes usually assigned to vegetable origin. Conservative stockmen expressed the opinion that $50,000 would not be an excessive estimate of the annual loss. The time at command was too brief to permit of more than a hurried inspection, but the presence of poisonous species of plants in considerable abundance was noted. Many others were under suspicion. Since the species here involved are mainly different from those investigated in Montana, a thorough study of the physiological properties of these Nevada plants is necessary.

During the latter half of the year an important step, from the standpoint of the laboratory side of the work, was taken. Dr. A. C. Crawford was appointed pharmacologist, a laboratory was equipped, and the study of the physiological aspect of poisonous plant problems has been begun.

DRUG AND MEDICINAL PLANT INVESTIGATIONS.

The Drug and Medicinal Plant Investigations are in charge of Dr. Rodney H. True. Field work has been carried on at two principal stations—at Burlington, Vt., in cooperation with the Vermont Agricultural Experiment Station, and on the Potomac Flats at Washington, D. C.

Field work.—At Washington about 4 acres are occupied by drug plants under observation. Here a careful study is under way to learn the proper methods of planting and cultivation and in some cases of harvesting and curing. Since about 45 species and varieties are represented, only small areas of any one kind of plant can be grown. In general, these plants fall into one of two classes, (1) native plants under-

going domestication, and (2) plants of foreign origin being studied with reference to cultivation in the United States. In order to afford proper conditions to those needing shaded situations, about one-fourth acre has been put under a slat shelter which gives about half shade. In most cases the plants are found to thrive well when once established. On the other hand, some information of an adverse character is accumulating, which will later be of use to drug cultivators. Among other things are the unfavorable nature of certain soils for certain drug plants, the liability of usually hardy plants, such as digitalis, to winterkilling in very severe winters, even in the latitude of Washington, D. C., and especially the difficulty of securing good germination. Seeds of drug plants offered in the market have frequently been found to be old and of poor quality. When fresh seed was used the difficulty with germination often disappeared. In some cases, however, this has not been true. Difficulty has been encountered in getting plants from the seed of golden seal, Seneca snakeroot, and a few others. In other cases the seeds seem to require a long period of rest, lying a whole season in the ground before germination.

In the case of golden seal, which has been under observation for about four years, the most practical method of propagation is by dividing the rhizome. The method of handling this plant has been fairly well worked out, and a paper on this subject by Miss Alice Henkel and Mr. G. Fred Klugh has been prepared for publication. The fact that this drug has appreciated in value to such a degree that it is now worth from $1 to $1.25 per pound and is difficult to obtain at that price leads to the belief that its cultivation for the drug market is feasible and promises fair returns. Since the demand is limited, however, overproduction is easily possible.

The work at Burlington has been of a somewhat similar nature and with many of the kinds of plants under observation at Washington, the effect of latitude and other factors of climate being sought. About an acre of opium poppies was grown during the past season and the product used chiefly at Washington for laboratory study. This plant does well in this northern situation, and tests showed that a good quantity of morphine is formed. The domestication of Seneca snakeroot is being attempted. The questions of seed production, germination, and propagation from cuttings are being studied, the discovery of a successful method of propagating this plant being particularly needed.

Laboratory work.—Experiments in curing drugs by means of artificial heat have been tried at Washington on a small scale during the last season. The results were very satisfactory as regards the appearance of the drugs, but in some instances the assay of leaf drugs left something to be wished in the way of active principle. Soil conditions are probably responsible for this defect, and in all probability it can be remedied by proper treatment. The laboratory investigations carried on in connection with this line of work are in the hands of Mr. W. O. Richtmann. His attention has been given chiefly to the working out of a commercially feasible method for obtaining the poppy alkaloids directly from the plants without the intervention of a large part of the expensive process of opium making, which necessitates hand labor. While Mr. Richtmann's work along this line is far from finished, it may be said that the prospect for ultimate success is excellent.

Mr. W. W. Stockberger has devoted his attention to structural problems in connection with the laboratory work. He has made a study of the drug known as pinkroot (*Spigelia marilandica*), and finds that collectors confuse several plants and that the drug known by this name is in reality a mixture of two and sometimes three kinds of roots. He has worked out the gross and structural characteristics of the plants concerned, so that it is possible to distinguish them, and a paper on this subject is nearly ready for publication.

Miss Alice Henkel has given special attention during the year to the weeds which furnish drugs now chiefly imported, and has brought together her results in Farmers' Bulletin No. 188, entitled "Weeds Used in Medicine." The widespread interest in this subject is indicated by the fact that the edition of 35,000 copies was exhausted in two months.

Preliminary studies in the process of curing drugs have been made in the field and laboratory, and have been followed far enough to make it clear that very important changes take place while curing, and that oxidizing ferments are in all probability an important factor.

GRAIN-GRADE INVESTIGATIONS.

The work of Grain-Grade Investigations has been carried on under the direction of Mr. C. S. Scofield. During the past fiscal year a careful study was made of the methods of grading grain as practiced in the more important market centers of the United States, and some extensive experiments were made with a view to determining the practicability of using accurate methods of mechanical analysis in the commercial grading of grain in actual practice. It has been found that grain inspectors have need of simple apparatus with which to test the quality of samples submitted for grading, and considerable attention has been devoted to devising such apparatus for this work.

The determination of moisture in samples of grain by actual drying tests has been found to be practicable in commercial work as a means of settling disputed cases, and also as the most efficient means of educating the judgment of the inspectors for the regular work of inspection. Attention has also been given to the study of methods devised and used by large manufacturers of the various cereals in testing quality in grain for different purposes. Although these manufacturers have devoted considerable attention to the methods of determining quality in grain, for the most part these methods are not known or are not used by grain inspectors. Consequently the discriminations made by manufacturers are not recognized by the grain trade, and continual dissatisfaction with commercial grading is one of the results. Not only is this dissatisfaction unnecessary and undesirable, but it has become evident that a more widespread knowledge of the methods of testing the relative values in samples of cereals would result in a very material improvement in the quality of cereals produced in the United States. When farmers can be assured of a slight increase in price for a slightly superior article in grain they will devote much more attention to improving the quality of grain produced than they do when practically the same price is paid regardless of such differences in quality. An earnest endeavor is therefore being made to learn as much as possible concerning the best methods for testing the quality of grain, and to bring this information to the attention of

grain inspectors, plant breeders, and farmers. This matter is already receiving the serious attention of the more important grain-trade organizations, and considerable effort is being made by these agencies through the distribution of samples of improved sorts of grain, and by hearty cooperation with those Government and private agencies that are working for the improvement of crops by breeding.

Aside from this work of investigating means for testing quality in grain, considerable attention has been given to the study of varieties of wheat cultivated in the United States. An extensive collection of the varieties of wheat has been made and the results of variety tests and descriptions of varieties are being secured from every possible source. This is being done with a view to standardizing the names of the important varieties of wheat, so as to avoid much of the misunderstanding and duplication of work which results from the present confusion of variety names among the different experimenters interested.

FIBER-PLANT INVESTIGATIONS.

Under the direction of Mr. Lyster H. Dewey, investigations begun during the preceding year on growing hemp in Utah and flax in Oregon have been continued. An exhibit of fibers and fiber plants has been prepared for the exposition at St. Louis—a time-consuming duty—and a beginning has been made in the study of cotton varieties.

Experiments with hemp.—In the spring of 1903 an experiment in the cultivation of hemp under irrigation was undertaken in cooperation with the experiment station at Logan, Utah. In portions of the experimental field, where the soil was not too shallow and did not dry out too quickly, the hemp made a fair growth. It was harvested, broken, retted, and spun under the direction of the Department. The fiber was of good color and very strong. This preliminary trial, while not entirely satisfactory, indicates a strong probability that hemp may be grown successfully under irrigation. A small experiment in cooperation with the Utah station has been undertaken this past spring to determine whether hemp may be grown successfully on seepage soils, of which there are large areas in Utah and in other States where irrigation is practiced. These soils have sufficient moisture, but are usually charged with salts, preventing the growth of grain or other field crops not specially resistant to alkali.

Work on flax.—A quantity of flaxseed of Russian, Belgian, and Dutch varieties was imported by the Office of Seed and Plant Introduction and Distribution in 1903, and sown under the direction of this Office at Salem, Oreg. A good crop of fiber flax was obtained in spite of adverse weather conditions. The Belgian and Dutch seed was of Russian origin, grown one or more generations in Belgium or Holland. There was little difference between these two kinds, and they were similar to flax from Russian seed grown one generation in Oregon. All of the flax from imported seed was superior for fiber purposes to that from seed grown several generations in Oregon.

SEED LABORATORY.

Seed testing.—During the past year 8,909 samples of seed have been tested in the Seed Laboratory under the direction of Mr. Edgar Brown. This is about three times the number of samples examined

in any previous year. Nearly all these have been tested for vitality, and determinations of mechanical purity have been made for 1,040 samples. As in former years, the samples have been received from numerous sources: 5,716 samples have been tested in connection with investigations being carried on in the laboratory, 1,129 samples for the Congressional Seed Distribution and other offices in the Department, and 1,024 samples have been sent in by farmers and seedsmen.

WORK ON GRASS AND FORAGE PLANT SEEDS.—The examination of all imported grass and forage plant seeds has been continued, and it is a matter of regret that the imports of certain objectionable seeds have increased. During the fiscal year ended June 30, 1904, 247,607 pounds of yellow trefoil seed were imported, as contrasted with approximately 67,000 pounds in the preceding year. The imports of Canada bluegrass seed increased in the same time from 450,000 pounds to 732,000 pounds. As the use of these two kinds of seeds is practically all for purposes of adulteration, steps to prohibit their importation or to put a stop to their fraudulent use are obviously important. Presumably, the wording of the following clause in the act of Congress making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1905, will, in a large measure, discourage the sale of adulterated and misbranded seeds:

> The Secretary of Agriculture is hereby directed to obtain in the open market samples of seeds of grass, clover, or alfalfa, test the same, and if any such seeds are found to be adulterated or misbranded, or any seeds of Canada bluegrass (*Poa compressa*) are obtained under any other name than Canada bluegrass or Poa compressa, to publish the results of the tests, together with the names of the persons by whom the seeds were offered for sale.

The quality of certain seeds imported during the past year was very low. This is notably the case with alfalfa, and attention has been called to this condition in a recent Farmers' Bulletin. Large quantities of grass and clover seed screenings continue to be imported from Canada to be used in the grading-down process in this country. The whole matter of seed importation is without restriction of any kind.

MISCELLANEOUS INVESTIGATIONS.—The experiments to determine the effect of climate and of cold storage on the vitality of stored seeds have been continued, with the result that methods have been developed by which most of our common vegetable, field, grass, and forage crop seeds can be economically put up so they will retain their vitality in the moist warm climate of the Gulf States or our island possessions, as well as when stored under ordinary conditions in the Northern States.

As a result of the study of the relative value of red clover of domestic and European origin, a planting of several acres has been made in Wisconsin with Russian seed from near Kief, with the view of conducting experiments with the hay to determine the relative feeding value of the smooth European and the hairy domestic forms.

Some preliminary work has been done on the harvesting and storage of corn for seed purposes. The results so far indicate that artificial drying should be resorted to whenever corn is necessarily harvested before it has reached maturity or when it contains an excess of moisture due to wet weather.

A series of experiments has been conducted in cooperation with the Bureau of Forestry on the germination of pine seeds. Methods of

testing have been worked out for 26 species, including most of those of economic importance.

A series of experiments has been begun in cooperation with the Laboratory of Plant Life History of this Bureau to determine the areas best adapted to the production of the various agricultural seeds, as well as to determine the effect of "change of seed." This work has been started with common red clover, and other crops will be taken up as rapidly as funds and assistance will allow. Fifteen lots of common red clover seed which had been grown in their respective localities for a series of years were obtained in the United States. These, together with a few samples of Russian seed, have been planted on 238 acres on 16 farms in 13 States.

FUTURE BOTANICAL WORK.

The general field work in tropical agriculture, which was partly suspended owing to the urgent necessity for pushing the cotton investigations, will be resumed.

Rubber culture continues to be the subject of paramount interest in this line of work. It is proposed to visit the rubber district of eastern Mexico, Panama, and Colombia, in order to extend our survey of the cultivated species of the Central American rubber tree (Castilla) with special reference to their conditions of growth and cultural prospects. It is of some importance to observe the tree in its most northern distribution and to secure seeds for experiments in Porto Rico and our other tropical islands. The results of experiments which have been made in Cuba, Trinidad, and other islands in the West Indies will, if possible, receive attention during the current year, in order that the prospects of such an industry in Porto Rico may be thoroughly understood. It is proposed to make practical application in Porto Rico of our studies of coffee culture in Guatemala, Costa Rica, and Jamaica, with a view to the introduction of methods which may increase the prosperity of the industry on which so large a part of the population of that island has been dependent.

Laboratory and field studies of cacao are also contemplated, in order to learn, if possible, the nature of the differences which determine the qualities and prices of the various commercial sorts, and the influence of climates and soils and methods of preparation. With proper selection of varieties and cultural methods, cacao growing is likely to meet with encouraging results.

In the poisonous plant investigations, the plans for the coming year contemplate the continuation of the field work, with special reference to the part played by plants in bringing about the condition known as "loco" disease. This work will consist of feeding experiments on a proper scale, supplemented by a careful laboratory study of the various tissues of the animals concerned. It is also desirable to extend the "loco" studies so as to include horses as well as sheep. The damage done to horse raising in many parts of the West is very great. In order to carry forward this investigation a larger sum of money will be needed for the purchase of animals for experiment than has been necessary in the work on sheep. It is proposed that during the coming spring a party be stationed in western Nevada to undertake a careful study of the conditions prevailing there with a view to

definitely fastening the responsibility for the losses upon the plants causing them.

In the pharmacological laboratory the working out of a practical antidote for cases of poisoning with poison camas and lupine is to be attempted, as well as a pharmacological study of the loco weeds and other plants regarded as responsible for the injury or death of human beings or of stock.

The field work in drug and medicinal plants will be continued at Washington, D. C., and Burlington, Vt., along the line of last year. It is important that provision be made at Washington for adequate facilities for curing the crop produced, giving a test of methods by both natural and artificial heat. Practical field apparatus is also needed in order to make possible the distillation of the volatile oils from those crops in which these are the useful constituents. The remodeling of structures now on the ground to provide for these needs is contemplated, but the money available this year is not sufficient to provide for more than a beginning. The full development of this important side of the work must await a larger appropriation.

At Burlington an increased area has been provided, in all about 4 acres, half of which area has been planted to poppies.

The laboratory work at Washington will continue the unfinished investigations along the lines mentioned.

In the grain-grade investigations the current work will be practically along the same lines as set forth in the preceding pages. Methods of testing will be given special attention and the work of describing the standard varieties will be continued.

Plans are made to continue work during the current fiscal year on flax, hemp, sisal, and the classification of varieties of cotton. Information will be collected in regard to the growth of numerous varieties of flax imported last year by the Office of Seed and Plant Introduction and Distribution and sown under the direction of the Department at several different stations. Investigations will be made in regard to improved methods for harvesting hemp and preparing the fiber. An investigation will be made of stocks of sisal plants from various sources to determine whether plants which have been acclimated to cooler climates than Yucatan may be more hardy and at the same time yield a good grade of fiber.

The outline of work planned for this Office for three or four years past has included each year an item for a study of the varieties of cotton, but for lack of funds and proper facilities this important work has not been undertaken until during the present season. The cultivation of a large number of American varieties of cotton, as well as foreign cottons, in connection with the cotton boll weevil investigations, offered exceptional opportunities to make a study of the plants in the field. The assistant who is devoting most of his time to this work will study the plants in the experimental fields in Texas and, so far as possible, on the plantations where varieties have originated and where the stocks are kept pure.

During the ensuing fiscal year work should be continued on the cultivation of hemp in the West and of sisal in Porto Rico in cooperation with the station at Mayaguez, and new work should be undertaken in the cultivation of matting rushes and in a study of the strength of fibers and their histological character.

In the work of the Seed Laboratory the examination of seeds for mechanical purity and vitality for actual purchasers will be continued. Studies of special groups will be made with a view to the identification of seeds closely resembling each other and the detection of adulterations.

The question of the preservation of the vitality of seed corn will be thoroughly studied, and the effect of maturity and of methods of storing and of kiln-drying will be determined.

The work already begun of locating the best areas for the production of red clover for seed and of determining the effect of "change of seed" will be carried on, and the study of other crops will be taken up as fast as the results of present work justify. The study of coniferous seeds will be continued and extended to include the seeds of other forest trees.

GRASS AND FORAGE PLANT INVESTIGATIONS.

The following is a brief review of the work of the Office of Grass and Forage Plant Investigations, which is in charge of Mr. W. J. Spillman:

INVESTIGATIONS WITH ALFALFA AND CLOVERS.

Mr. A. S. Hitchcock, who has been placed in charge of investigations of alfalfa and clover, is studying several varieties with special reference to their adaptability to the diverse conditions prevailing over the wide area in which these crops are cultivated. Alfalfa is a standard forage crop throughout the western half of the United States, especially in the irrigated districts. In cooperation with the Utah Agricultural Experiment Station a series of experiments is in progress to determine the amount of water necessary and the most favorable method of application to insure a maximum yield of alfalfa, and also experiments to determine the minimum application of water required to secure a crop. It has been found that abundant irrigation throughout the season, 61 inches of water being applied, gave a yield of 6.2 tons per acre, while four irrigations in the early part of the season with only 25 inches gave 5 tons per acre, showing that beyond a certain supply the excess is wasted. In the semiarid regions where it is desirable to raise alfalfa without irrigation, experiments are in progress, in part in cooperation with the experiment station in Nebraska, which will test the adaptability of alfalfa from different States and countries to these conditions and which will determine the best method of culture to obtain a stand and grow good crops in these regions.

In cooperation with the Missouri experiment station alfalfa has been studied with reference to acidity of the soil and the relation of this and of moisture to the production of the nitrogen-producing organisms. The production of tubercles was found to be greatly hindered by the acidity of the soil, but when the acidity was corrected by the application of lime a vigorous growth ensued. Since much of the soil in the Eastern States otherwise suited to the growth of alfalfa shows an acid reaction, it is necessary to counteract this by the addition of lime or by other treatment which will place the soil in proper condition. The experiments with cover crops in cooperation with the Delaware experiment station have shown that upon a clay soil alfalfa is an excellent plant for this purpose when sown in the autumn,

making a growth of as much as 18 inches by November and passing the winter in good condition.

Attention has been directed in recent years to the need of perennial forage plants in the Southern States, especially in the cotton belt, in view of the ravages of the cotton boll weevil. Numerous experiments and tests have been instituted in this section to determine the availability of alfalfa for this purpose. In many localities, notably the valley of the Red River and the alluvial lands along the lower Mississippi, alfalfa is now giving large returns, and it is planned to extend its culture over as wide an area as possible in the Southern States.

In order to aid in introducing this plant into new localities in the South, seed was distributed to a number of responsible farmers, who grew the crop under directions from this Office and reported results. Although there were several failures, due to improper climatic or soil conditions, the successes were sufficiently numerous and so widely distributed as to leave no doubt that, with sufficient care in meeting the conditions necessary for its growth, alfalfa can be cultivated throughout the greater part of the South. That it can also be depended upon as a perennial source of forage is shown by many fields of great age, notably one at Anderson, S. C., sixty-nine years old, and still producing fairly well. A similar series of experiments has been tried north of the Ohio River. These experiments have resulted in many successes, distributed over a variety of soil conditions and in States from Minnesota to New York and Connecticut. The failures are due to an acid condition of the soil, to lack of nitrogen-producing organisms, and to winterkilling. It has been shown that strains of alfalfa capable of withstanding severe winter conditions of the Northern States are already in existence, but that alfalfa grown from northern seed will succeed where that grown from southern or western seed will fail. In many cases successes follow repeated failures upon the same land, probably owing to the introduction of the nitrogen-forming organisms in the repeated trials. The experiments will be continued with the intention of determining the conditions necessary for successful alfalfa culture throughout the United States.

In the Northern States east of the Missouri River red clover is a standard legume for meadows. Under certain conditions it is becoming difficult to obtain a stand of clover, and this Office has instituted a series of experiments to determine the cause of and remedy for these failures. It has been shown that the failures which are usually ascribed to clover sickness may be due to acidity of the soil, the lack of nitrogen-gathering organisms, or to the presence of insect or fungus enemies. Crimson clover is being tested, especially in the Middle Atlantic States. At the Delaware experiment station, cooperative experiments show that crimson clover is one of the best of the cover crops for orchards. Experiments are under way to bring into cultivation certain native species of clover, such as buffalo clover, which give promise of adaptability as winter crops in the South. Many other crops are being tested for special conditions in various parts of the United States.

SOIL AND SAND BINDERS.

Increased attention has been given to the problem of reclaiming the drifting sand dunes found along the coasts of the Atlantic and Pacific oceans, the Great Lakes, and the valley of the Columbia River. A

survey of these regions has been nearly completed and experiments have been inaugurated at several points, particularly on the east shore of Lake Michigan, at Fort Stevens and Coos Bay on the Pacific coast of Oregon, and the very troublesome dunes along the Columbia River from The Dalles to Riparia. The results of the investigation made in Europe upon the methods used there for controlling sand dunes have been published in the form of a bulletin (Bureau of Plant Industry Bulletin No. 57). A detailed examination of the Cape Cod sand dunes and the methods of reclamation used has been made, a report of which has been issued as a bulletin of the Bureau of Plant Industry (No. 65). The investigations along this line have so far advanced that recommendation can now be made for the treatment of shifting dunes along the seacoast and the shores of the Great Lakes.

On the Pacific coast of Oregon and Washington the damp climate permits the successful use of beach-grass planted at such wide intervals as 4 feet, and it has been shown that areas under these conditions can be reclaimed at a cost of about $8 per acre, but along the Columbia River the conditions are especially severe on account of the floods in June, followed by an extremely dry summer. Mr. J. M. Westgate will spend the summer in this region in order to inaugurate a series of experiments bearing upon the solution of this problem. A working plan has been developed which it is proposed to test at The Dalles. At present sand fences in that locality are placed in such a position as to divert the sand to a position parallel to the railroad instead of across the tracks. However, large quantities are deposited upon the track, which it is necessary to remove with scrapers. This sand is finally blown into the river farther east and at the next flood is brought down and deposited, completing the cycle. It is hoped that the sand deposited on areas above high-water mark may be held in place by suitable plantings and that the remainder can be washed farther down the river.

The work with soil binders for holding cuts and embankments has been continued, and plants have been tried which promise to be suitable for this purpose. It has been found that the only practicable method for preventing the slipping of the soil upon the sides of very deep cuts in clay soil is to reduce the slope and give proper drainage. Where the soil on the sides of the cuts will permit of a growth of vegetation, certain grasses with creeping rootstocks, such as quack-grass and Canada bluegrass, or, in the South, Bermuda grass, have been found adapted to the conditions and will soon cover the surface with a firm sod.

The work with soil and sand binders is in charge of Mr. A. S. Hitchcock, assisted by Mr. Westgate.

RANGE INVESTIGATIONS.

Investigations upon native pasture lands have been continued during the past year by Dr. David Griffiths.

Improvements of native pastures.—Experiments looking to the improvement of native pasture lands are now in progress in the States of Washington and California and the Territory of Arizona. In the State of Washington investigations are conducted for the purpose of determining the best method of renovating worn-out mountain sheep ranges. The need of the section appears to be more summer feed, because winter feed can be furnished for more stock than can be fed upon the native pastures during the summer. The large areas of

desert lands used for winter range, supplemented during the past ten years by the irrigated hay meadows, especially alfalfa meadows, have brought about a shortage of summer range. Enough work has been done during the past year to demonstrate the futility of seeding the highland summer ranges without some cultivation. It appears, however, that this cultivation need not be thorough in order to establish valuable forage plants which will add very materially to the summer feed supply.

Investigations in Arizona are conducted under the most trying conditions. There the rainfall varies from 6 to 13 inches per annum, and much of this often falls in the cool winter season when only plants of minor forage value can grow. Better success has been attained with Colorado grass (*Panicum texanum*) than with anything else thus far. This plant is an annual, but it yielded at the rate of from two-thirds to 1 ton per acre on small areas held by dams during the past year. It is thought very doubtful whether any of the valuable perennial forage plants can be established upon these arid mesas. The indications are that some of the annual forage plants, although not furnishing such palatable feed when dry, are much more likely to succeed. Some of these are very valuable and have spread over large areas during recent years. The most important plant belonging to this class is alfilerilla. Sheep have been largely instrumental in spreading this plant, and it is believed that a systematic effort in herding at the time that the plant is ripening will do much to spread it.

Considerable effort has been made during the past year to become thoroughly acquainted with the different pasture areas of the Southwest, especially the Territory of Arizona, by personal visits of officers of the Department to representative regions. In this way much has been learned in regard to the methods in vogue, the capabilities of pasture lands, and the needs of the different sections. The results of these observations will soon be issued in a bulletin which is now in press.

Investigations in California have also been inaugurated under trying conditions. The forage plants upon the west slope of the Sierras are very largely annual in their character and therefore furnish but little feed during the dry summer season. It seems highly desirable to determine what forage plants can be grown upon the small meadows of this region. It is somewhat doubtful whether anything more than proper management can be recommended for the general foothill and mountain regions, but it is thought that the feed can be very materially increased upon the small meadows which now produce little forage aside from the scanty growth of sedges which prevails there. To determine what can be produced with little cultivation is highly desirable, and the ranchers who occupy these lands are in great need of better feed at lower altitudes than those at which they are now able to secure it.

Assistance to ranchers.—Many requests come to this Office from time to time for assistance and advice in the management of native pasture lands. These come especially from owners of large blocks of land secured mainly through purchase from the various holders of railway grants. To these requests as liberal response as possible has been made. Personal visits have been made to several localities for the purpose of consulting ranchers relative to their methods and offering such advice and suggestion as seemed necessary.

USE OF THE CACTUS PLANT.—The cactus, a form of vegetation which covers such vast areas of the arid Western States, is attractive to the traveler on account of its oddity, but to the stockman it is of little interest except for its noxious weedy character. In some sections of this country, in Australia, and in countries bordering on the Mediterranean, considerable use has already been made of certain species of this group of plants. Estimates that have been made of their value as forage plants vary widely. That they have been fed with success to cattle and hogs there seems to be no question. Some ranchers in Colorado and Texas are very enthusiastic on the subject of cactus feeding, and ask that experiments be inaugurated for the purpose of determining the best method of propagating and feeding the plants. Several methods of making the spines innocuous have been practiced to some extent in this as well as other countries. In some cases the spines have been burned off; in other cases the whole plant has been steamed, and in still others the plants have been chopped and the spines allowed to soften in the juices of the plant.

Inasmuch as there are many species of cactus which are of possible utility in this connection, it seems highly desirable that experiments be conducted in several places where the different forms grow. As the water and ash contents of the different species are variable, chemical analyses will be necessary. Feeding experiments are necessary also and should be conducted with several species in order to make the work at all complete. Besides determining their feeding value and the best method of handling them, it is most essential to secure data regarding the behavior of the plants when they have been once harvested, as well as to determine the best methods of propagating them. These points will have to be determined in the localities where the plants grow. The cactus is a plant of slow growth. There are some species in western Texas which are said to spread rapidly and to take possession of some areas of range country. It is highly essential that we know how often a crop may be harvested from a certain area, and whether it will pay to attempt to propagate from cuttings, or whether the natural growth of the country is all that can be expected. In certain sections of western Texas one or two species are said to be weedy in character and to have taken possession of extensive stretches of country during the last ten years. If these plants can be transformed into feed for stock at a reasonable expense, two purposes will evidently be gained, namely, a weedy plant will be rendered useful, at least as a supplementary forage plant, and a source of food will be found where it is much needed.

INVESTIGATIONS OF STANDARD GRASSES.

A most promising line of work lies in the study of varieties of our common meadow and pasture grasses. It is well known that all grasses are subject to variation in much the same way as other plants, but heretofore no definite efforts have been put forth to select varieties marked by greater vigor, height, or leafiness, and which consequently would yield larger crops.

Some pioneer efforts in this direction have been carried out by Dr. A. D. Hopkins with timothy, and by Mr. A. B. Leckenby with smooth brome-grass and with Kentucky bluegrass.

Doctor Hopkins, at present connected with the Bureau of Entomology of this Department, formerly of the West Virginia experiment station, for many years grew timothy for seed. For this purpose the crop is ordinarily sown thinly, so that during the first harvest year the plants are sufficiently distinct to permit of the observation of individual plants. Many years' close observation showed that the crop consists of a large number of constantly recurring forms quite easily distinguished. A number of plants, each representing one of these forms, were taken up and separated into as many parts as the nature of the case permitted. In this way each plant became the parent, by division, of many plants, all set side by side in a plat. When seed was harvested from these plats it was found that the plants reproduced faithfully the characters of the original selection. Each original selection, therefore, became the parent of a variety. Several of these varieties are now growing in the grass garden of the Department of Agriculture, where they have been the object of careful observation during the past season. They differ markedly in character of growth, earliness, size, etc. Some of them are evidently far superior to the ordinary timothy as grown by farmers (which is a mixture of superior and inferior varieties), some for seed production, others as hay plants, and others as pasture plants.

In a manner exactly similar, Mr. Leekenby, while director of the Eastern Oregon experiment station, isolated ten varieties of bromegrass (*Bromus inermis* Leyss.), as different in agricultural value as the ordinary varieties of wheat. He has also isolated a larger number of varieties of Kentucky bluegrass (*Poa pratensis*), differing to a remarkable degree in character of growth, and consequently in agricultural value.

Through the kindness of Doctor Hopkins, this Office is in possession of several of his varieties of timothy. It is expected that seed of three of these varieties will be available for distribution in quantity in 1906 and of the other nine in 1907.

It is planned to investigate other important grasses in a similar manner, among them orchard grass, redtop, tall fescue, and reed canary grass. The last named is a valuable hay grass for some sections of the country, but owing to its habit of dropping its fruit readily the cost of the seed is high. Field observations disclose the fact that some individual plants hold their seeds much longer than others, and it is believed that by selecting from such individuals the seed habit may be corrected so as to make this a very important grass.

In cooperation with the Washington experiment station we have already inaugurated investigations of the character indicated above, and it is desirable that in another year similar investigations be undertaken in other States—particularly in such localities as have distinctly different soils and crops. This work is under the direction of Mr. C. V. Piper.

TECHNICAL SYSTEMATIC WORK ON GRASSES.

A monograph of the genus Agrostis, by Mr. A. S. Hitchcock, is completed and will soon be published. The types of all the North American species have been studied by the author, and the confusion which has so long enshrouded this genus has been cleared away.

A similar monograph of the genus Paspalum, by Mr. G. V. Nash, is in manuscript. With a few unimportant exceptions Mr. Nash has

been able during the past few years to study the types of the species of this very difficult genus, and his monograph will make clear many misinterpretations of botanical writers.

So far as the herbarium material will allow, monographs of several other genera are well in hand, namely, Festuca, Melica, Sporobolus, Oryzopsis, Stipa, and Bouteloua. We are preparing a list of all the North American grass species of which no original or authentic specimen exists in the herbariums in this country, and are indicating where the type specimen is to be found. As soon as opportunity offers these type specimens will be studied with a view to completing monographs of the above-mentioned genera on the standard demanded by present-day systematic work. The general direction of the systematic work is under Mr. C. V. Piper, assisted by Mr. P. L. Ricker.

HERBARIUM.

Mr. Piper is making a careful study of the grass herbarium, with a view to detecting species not known in this country which may prove to be of economic value in some one or more phases of our varied agriculture. There are many species utilized in the agriculture of other countries which have never been tested in the United States. It would seem more than probable that some of these are likely to prove of great value. A special search is being made for species of a weedy nature which may add largely to the amount of forage on semiarid western ranges. It is well known that many European annual grasses and other plants have become established on the ranges in the West, and some of these are now among the principal forage plants. It is altogether likely that other European species are much better than those which have been introduced by chance, and an endeavor will be made to secure seeds of such grasses and to test them with a view to their introduction on the ranges.

COOPERATIVE WORK WITH STATE EXPERIMENT STATIONS.

For several years this Office has been conducting experiments on grass and forage plants in cooperation with certain State experiment stations.

Utah Station.—In the State of Utah tests have been made with a number of grasses and clovers to determine the yield that may be expected under irrigation with limited quantities of water. The importance of these experiments will be understood when it is stated that there are many localities where there is abundant water for a single irrigation in spring or early summer, but where water is not available later in the season. The experiments had in view the finding of forage plants suited to such situations. While the experiments are not yet completed, the results are already of much interest. For instance, in the climate of Logan, Utah, it is shown that a single moderate irrigation in June produced a profitable crop of brome-grass hay, something over twice the yield obtained from the same grass without irrigation. An extra irrigation in July did not increase the crop nor did continued and abundant irrigation during the summer produce a yield much in excess of a single irrigation in June. In the case of orchard grass a single irrigation in June gave no greater yield of hay than no

irrigation, and in both cases the crop was hardly a profitable one. The plat irrigated in June and again in July gave a profitable yield, amounting to nearly as much as that on the plat irrigated throughout the summer. *Elymus triticoides* without irrigation gave two good cuttings of hay the second year, amounting to 2.8 tons per acre. With abundant irrigation throughout the season the yield was only 3.2 tons. From this it would appear that this grass is abundantly worthy of attention on farms where irrigation water is not plentiful. Two irrigations of *Agropyron spicatum* produced satisfactory yields of hay; while with one irrigation and no irrigation the results were unsatisfactory. In the case of *Bromus marginatus*, one of the very promising wild grasses of the Pacific Northwest, abundant irrigation throughout the season produced nearly 5 tons of hay per acre. Without irrigation this grass was a failure. These results indicate that bromegrass, orchard grass, and *Elymus triticoides* are deserving of further attention in regions where irrigation water is not abundant.

Missouri Station.—In connection with the Missouri experiment station we have been studying a system of forage crops for the production of beef, particularly for the rapid development of calves into what is known on the market as "baby beef." In connection with that station we have also made a thorough survey of the soils of the State with reference to their adaptability to the alfalfa plant. Dr. George M. Tucker, who has been in direct charge of this work, believes that alfalfa can be successfully grown on many soils where it is not now grown and where it has heretofore failed when tried. One of the most important causes of failure he reports to be acidity, particularly of upland soils. This would indicate that by a proper application of lime alfalfa might be successfully grown on these soils. Doctor Tucker reports that in the northwestern portion of the State and in the extreme southeastern portion, in both of which sections the soils are deep and alluvial in character, alfalfa has become a standard and a highly valued crop.

Kentucky Station.—Cooperative investigations in connection with the Kentucky State experiment station, at Lexington, have continued during the past year. These cover the study of the rotation of crops and its relation to grasses and forage plants and to the management of the farm; annual forage crops in their relation to yield and suitability for green feeding and silage purposes; the best methods of establishing and maintaining meadows and pastures; the study of numerous little-known grasses and forage plants with a view to selecting for further test those that possess characters which apparently render them of economic value.

Tennessee Station.—In connection with the Tennessee State experiment station we are studying problems similar to those in Kentucky. In addition we are studying methods of hay making and the use of fertilizers on forage plants.

Washington Station.—In the State of Washington important investigations have been conducted between this Office and the State experiment station relating to the present condition of the ranges of the State and the methods required to bring them back to a state of productivity. It is apparent from these investigations that the main difficulty in that State is a shortage of summer pastures. The large quantity of

alfalfa and other hay produced which is available for winter feed enables the stockmen to keep more stock during the winter than they can find range for during the summer. This has caused serious overstocking of the summer ranges. Extensive experiments have been instituted on one of the most important summer ranges in the State with a view to ascertaining whether the ranges can be improved by reseeding; also to ascertain the effect of protecting them from the depredations of stock for one or two seasons. The results indicate that some of the more valuable grasses can be established upon open spaces in the timbered section of the mountain ranges if properly protected against nomadic herds of stock.

We have also undertaken with the Washington State Experiment Station the study of the standard grasses and also some of the more valuable wild grasses, with a view to ascertaining the most valuable varieties.

WEIGHT AND VOLUME OF HAY.

A great many farmers sell hay by volume, because of lack of weighing facilities. It is difficult to estimate the number of cubic feet in a stack of hay, and a good many rules are in vogue for this purpose. One such rule has been adopted by the legislature of one of the Western States. This Office has been investigating the subject during the past year and finds that the rules in common use—and particularly the one which is the legal rule in one of the States—give results far too low. The rule established by law is to multiply the width by the distance over the stack, multiply this product by the length, and divide by 4. In eleven cases this rule gave results varying from 21.5 to 34.9 per cent too small, an average error of 29.6 per cent. In other words, this rule loses to the farmer more than one-fourth of his hay. Our investigations have led to the adoption of the following formula: $0.225\ (O - W)\ OWL \div H$; or, in ordinary language, subtract the width from the "over," multiply the remainder successively by the over, the width, the length, and by 0.225; divide this product by the height. The quotient will be the number of cubic feet in the stack. In our investigations the errors resulting from this rule varied from 2 per cent too small to 4.7 per cent too large. These investigations will be continued during the current year. We have yet to learn the average volume of a ton of hay under different conditions.

ARLINGTON FARM.

LEGUMINOUS FORAGE CROPS.—At the Arlington Farm Mr. C. R. Ball has conducted varietal tests with cowpeas, soy beans, gram (*Phaseolus mungo*), and sorghum. All obtainable domestic and foreign varieties, named and unnamed, have been secured and grown for the purpose of identifying them and becoming familiar with their appearance and habits. Not infrequently two very different things have been found passing under the same name, or an old and well-known variety has come to light under some new designation. By thus securing seed from widely separated sources the possibility of obtaining forms or varieties of value for further selection and improvement is greatly increased.

In the work with the legumes named above particular attention is being given to several lines of importance. Early maturing varieties suitable for the production of two or more consecutive crops in a given season or for extension into increasingly northern latitudes are much in demand. Among cowpeas of this character are the New Era and the scarcely distinguishable strain known as Down's Early Ripener, Early Black, Early Blackeye, and Early Whippoorwill. Warren's Extra Early, Warren's New Hybrid, Sherman's Northern Prolific, and the Iron cowpea have become sufficiently acclimated to give promise of value in northern regions. It is worthy of note that the four varieties last mentioned all belong to the Clay group and that the first three are, indeed, very similar in appearance. Sufficiently early varieties of soy beans are in hand. Among the green and the black varieties especially, many require only ninety to one hundred days from date of germination to maturity.

Another very desirable character in these legumes is a habit of growth sufficiently erect to permit the use of ordinary haying machinery in handling them as a hay crop. Several varieties of cowpeas, under test, possess this valuable character. Fortunately they represent, in point of maturity, early, medium, and late varieties. Practically all varieties of soy beans are erect in growth and consequently suited for haymaking. Several varieties of the gram are erect, though of a short and stocky growth. The form secured from Prof. C. C. Newman, of Clemson College, South Carolina, is the tallest and most erect in habit of any so far studied.

Another desirable feature in these plants which is receiving attention is leaf-holding power. The habit of dropping leaves throughout a long fruiting season has been a great disadvantage in utilizing them for hay and pasturage. Among all varieties of cowpeas tested here the Iron has shown itself to possess probably the strongest leaf-holding characters of any, while the common black cowpea is decidedly the opposite in habit. A fourth feature which will be made the subject of careful selection during the present season is evenness of ripening seed in these leguminous plants. The realization of this will go far toward permitting the successful use of the harvesting machinery commonly employed with the garden bean.

Sorghums.—The work at the Arlington Farm with the varieties of this important crop has been more largely directed toward securing more complete knowledge and identification of the numerous domestic varieties, both saccharine and nonsaccharine, than to a comparison of their values for green feeding, hay, or silage purposes, or a study of their adaptations to different conditions. In the work of the single season just passed it has been possible to group with a fair degree of accuracy all domestic forms, though the multitudes originating from foreign sources have not yet been sufficiently studied with regard to their habits and characters, either here or under other conditions, to allow their certain classification, although much has been done toward approximating them to the positions which they will probably occupy permanently.

PROBLEM OF DOMESTICATING NATIVE GRASSES.

There are certain of our native grasses, especially some of those growing in the Western States, that have given decided indications of being worthy of investigation with a view to their introduction into

cultivation. A quantity of seed of a number of the more promising species has been secured and these seeds are now being tested for hay production under ordinary farm conditions. These experiments are confined mostly to the arid and semiarid portions of the Middle West.

Between longitude 95° and 115° west there are extensive areas that are yielding comparatively small forage returns on account of the arid climatic conditions. Very little hay is produced on these areas, and for grazing a large number of acres per head of stock is required. The ultimate object of bringing native grasses under cultivation is to increase the yield of hay. The first consideration has been to find grasses that can be relied on to produce a fair crop in this dry country. In portions of the country where the mean annual precipitation is only about 12 inches, a grass that will produce hay in quantity is of great importance, even if its quality is somewhat inferior. Several of the grasses under experiment give promise of success, and we are now at work to determine the treatment that must be accorded them to make them reliable crops. Some of the best of our wild grasses have such poor seed habits that they can not be domesticated. We are searching for strains of them with better seed habits. In the South, where desirable tame grasses are needed, there are wild grasses of undoubted agricultural value. These are to be tested under farm conditions and their value determined. Mr. R. A. Oakley is devoting all of his time and energy to problems of this class.

WINTER PASTURES FOR THE SOUTH.

During the past few years live-stock growing has received considerable attention in the Southern States, and in some sections it bids fair to become a leading industry. The high price of beef and dairy products prevailing throughout the South, the large areas of pine lands that are rapidly being stripped of their timber and which are better suited for grazing purposes than for other lines of agriculture, the advent of the cotton boll weevil, which is causing many planters to turn their attention toward a more diversified system of farming, the natural climatic advantages which render it possible to have good grazing for the greater portion of the year and make the construction of expensive barns for sheltering the animals during the winter months unnecessary are all economic factors which are giving an impetus to this great industry and make its future outlook most encouraging. During the spring, summer, and autumn months an abundance of good pasturage may be had in almost any locality, but the pasture grasses are killed by the first frosts. As the average stockman in the South makes little or no provision for feeding his stock during this period of the year, many of the animals die of starvation, and those which survive the prolonged fast are little more than skeletons when the spring season arrives. During the unusually severe winter just passed, the death rate of the range cattle was much greater than usual in Florida and Georgia, stockmen estimating their losses at from 3 to 30 per cent. This does not take into consideration the loss resulting from shrinkage in weight and the impaired vitality of the surviving animals. It is evident from those facts that one of the most serious drawbacks to successful stock growing in the South is the question of winter pastures, and a satisfactory solution of this problem will give to the South unsurpassed advantages for the eco-

nomical production of beef and dairy products. The necessity for a thorough investigation of the conditions looking toward a solution of this important problem is at once apparent, and extensive experiments should be conducted by the Department with a view to lessening this difficulty and determining how the southern stock grower may best secure pastures which will furnish his animals grazing throughout the entire year. This work should be conducted along the following lines: (1) The introduction of new varieties of grasses, legumes, or other plants which give promise of being valuable under the existing conditions; (2) a more thorough dissemination of the plants that are already known to furnish grazing during the winter months; and (3) the improvement and domestication of some of the most promising winter-growing plants that are indigenous to the region. The importance of this problem can not be overestimated. Mr. M. A. Crosby is devoting himself to its solution.

GULF COAST CROPS.

Forage conditions along the Gulf coast from central Florida to Texas are peculiar, in that a number of important forage crops not known elsewhere occupy an important place in the agriculture of that section. The principal crops in this list are the velvet bean, the Florida beggar weed, Mexican clover, and cassava. Comparatively little attention has been given these crops by agricultural investigators. Even from Florida, where they are the leading forage crops, we have numerous calls for information concerning them. This is due to the fact that the cultivation of forage crops is comparatively new to that section of the country. A few years ago orange culture was the principal industry. This industry was destroyed in a single night by a heavy frost, and since that time the development of live-stock farming has been marked and the cultivation of forage crops has developed rapidly. In order to be able to encourage live-stock farming in the section in question, we desire to secure information concerning these peculiar crops. It is necessary to learn the place which each of them may occupy in the agriculture of the section, and to determine the value of each for feed and how to grow and utilize them to the best advantage. It is also necessary to study their adaptability to various soils and to encourage their distribution along the Gulf coast in localities to which they may appear to be adapted. Some of these plants exist in considerable variety. It is necessary to study these varieties with a view to selecting those which can be made most useful.

This work has been placed in the hands of Prof. S. M. Tracy, of this Office. During the past two years he has investigated the cassava crop, and it has been ascertained that this crop is especially valuable as feed for cattle and hogs, taking the place of corn in a section where the yield of corn is so slight that it hardly pays to grow it. It has been found that there are two important difficulties to be overcome before cassava can become generally useful; these relate to the keeping of the seed canes over winter and to securing a full stand of plants in the field. The latter difficulty has practically been solved. We find that by first sprouting canes in cold frames or hotbeds and transplanting the sprouted canes we are able to secure a practically perfect stand, thus doubling the yield obtained by methods formerly in vogue. The best method of keeping the canes over winter has not

yet been learned, though it has been shown that much of the difficulty arises from harvesting immature canes. Extensive experiments are now in progress with a view to solving this important problem. In this connection it may be stated that of the 42 varieties of cassava now in the possession of the Department one of these, coming originally from near the snow line in the Andes Mountains, canes of which were secured late last spring, produced seed in southern Mississippi last year. Considering the fact that the canes were planted fully two months later than it is best to plant them, this fact is regarded as of great importance. Most of the seed did not mature properly, but we now have one healthy plant produced from this seed. Should it prove possible to propagate a good variety of cassava from seed, the most important difficulty yet remaining in the cultivation of this plant would be removed.

It is well known that the roots of the cassava plant, the part which is used for forage, contain more or less of prussic acid. Varieties containing a considerable amount of it are known as "bitter cassava" and are decidedly poisonous unless cooked. Varieties in which the prussic acid is present in quantities so small as to produce no physiological effects are referred to as "sweet cassava." Arrangements have been made with the Bureau of Chemistry for studying the prussic acid content of the roots of forty-two varieties now in our possession. We hope to be able to secure varieties practically free from this objectionable substance.

In central and western Florida the velvet bean is an important hay and pasture plant. On account of the great length of its vines there is much difficulty in making hay from this crop. We are paying particular attention to methods of handling it for haymaking. We have also outlined plans for determining the limit of its profitable culture.

The Florida beggar weed is important both as a forage plant and as a soil renovator. It is used extensively for pasture and to some extent for hay. We are endeavoring to learn the possibilities of this crop.

Mexican clover is a plant belonging to the madder family and having the habits of crab-grass. It is cut for hay extensively in some localities along the Gulf coast, and where it is best known it is considered a valuable addition to the forage plants of the section. The most important piece of work to be accomplished in connection with this plant seems to be to distribute it into localities where it is not at present found and where it would undoubtedly add to the forage resources.

FORAGE CROPS FOR SOUTHERN FLORIDA.

The recent extension of the railways into southern Florida has opened up extensive areas of new land for agricultural and horticultural purposes. The difficulty of bringing the soil into a state of productiveness and the heavy application of fertilizers which it requires render intensive cultivation necessary. The development of dairies to supply at least the local demand for dairy products promises to constitute an important factor in the extension of the system of diversified farming.

The problem of providing the necessary forage plants presents several difficulties. Very few valuable grasses are found in southern Florida. The Department is investigating the merits of Guinea grass and Para grass, both of which give promise of value as forage.

Guinea grass is utilized in isolated localities in that region as a forage plant, being usually cut and fed green. Para grass is also used to a limited extent and has shown itself adapted as a pasture grass for muck soils. Neither of these grasses is at present grown from seed but both are propagated by cuttings or divisions of the roots. Seeds and cuttings of these grasses have been obtained from various localities in the West Indies, and experiments will be tried to test growing these grasses from seed.

PACIFIC COAST PROBLEMS.

Mr. Byron Hunter has been placed in charged of forage problems on the Pacific Coast, with headquarters at Pullman, Wash., where he cooperates with the experiment station of that State, as well as with the experiment stations in all of the Pacific Coast States. On account of the fact that a large portion of that section has been recently settled, and also on account of the great variety of soils and the variation in climate due to altitude and rainfall, the problems of the region are exceedingly complex and many of them important. Over a large part of the coast region, particularly in those sections best adapted to wheat, the common system of cropping is to grow wheat every alternate year and summer-fallow the land in other years, thus securing only one crop in two years. We have undertaken to ascertain whether the land can be utilized for growing forage crops in the idle year.

One of the most important hay crops in the wheat-growing section of the coast region is wild oats. Very little study has been given to this crop and we are undertaking to ascertain its value for feed and the methods by which it must be handled in order to prevent it from giving trouble as a weed. As in all new regions, there is much to be learned regarding the grasses which are best adapted for use in meadows and pastures. This problem is rendered more complex from the fact that the climate in different sections varies from extreme aridity to a rainfall of over a hundred inches, and the altitude from below sea level to the snow line on the mountains. We are testing a considerable number of grasses for hay and pasture purposes on arid and semiarid lands. Some of these are proving successful and we are attempting to introduce them into general use.

JOHNSON GRASS.

Johnson grass is the worst weed in the South. At the same time it produces three good crops of hay in a year. It would undoubtedly be the most valuable hay grass in the South were it not for its weedy character. Experience has shown that it is practically impossible to confine it to one part of a farm; for this reason, methods of exterminating Johnson grass are of the highest importance to farmers throughout the South, for it is one of the most widely distributed weeds in the cotton-growing States. A great deal of experimental work has been done with a view to determining whether or not it can be exterminated, and, if so, to learn how it may best be done. The opinion is general among farmers and experimenters in the South that it is practically impossible to eradicate Johnson grass when it is once established on the farm.

Owing to the importance of the problem, experiments were outlined by the Agrostologist during the summer of 1902 with a view to testing

different methods of destroying this weed. They were conducted on the farm of Mr. J. B. Gay at Columbus, Tex. These experiments have been completely successful. On one of the experimental plats not a sprig of Johnson grass has appeared since September, 1903. On another plat an excellent crop of cotton was grown during the summer of 1903, in which it was necessary to search closely to find any Johnson grass. The land on which these experiments were conducted had been abandoned to this grass and had been used as a Johnson grass hay field for some years. On land a few rods away Johnson grass was so plentiful in the cotton that the crop was an entire failure. During the present year we are handling 15 acres of land on Mr. Gay's farm by methods similar to those which proved most successful on the experimental plats. The essential point in the methods which proved successful is to remove from the soil in the autumn as many of the rootstocks of the grass as possible. Although we have had much difficulty in finding an implement properly suited to this work, one which promises to be satisfactory has now been secured and will be tested on an extensive scale during the present season. If it is as successful as it is hoped, we shall undertake demonstrations at several points in the South next year on a scale sufficiently large to win the confidence of farmers who have to fight this dreaded pest, and under conditions that will enable as many farmers as possible to see the work.

COARSE FODDERS.

The most important forage plant in the United States is corn. As this crop has been a standard in this country since the earliest attempts at agriculture, the leading problems relating to it have long ago been solved. There are yet, however, some problems of more or less importance. One of the most important is to find varieties adapted to southern and western conditions. There is an increasing tendency to use this great forage crop for soiling and silage purposes. As this method of utilizing the crop is comparatively new, there is considerable difference of opinion among farmers as to the proper method of planting and growing the crop for these purposes. Questions of this kind must be decided by the results of experiment, supplemented by the combined experience of numerous farmers. We are proceeding toward the solution of the question along both lines. Chemical analysis and a mere matter of yield per acre are not sufficient to decide questions of this character. The matters of convenience in handling and acceptability to stock are as important as chemical composition.

In the South and in the semiarid portion of the West, and even on irrigated lands in the Southwest, the different varieties of sorghum, both saccharine and nonsaccharine, occupy a position of the highest importance as a fodder and hay crop and to some extent as a grain crop. The ordinary saccharine sorghums yield more tons of forage per acre ordinarily than do the nonsaccharine kinds, but the different varieties of Kafir corn possess a distinct advantage over the sorghums in that their seed is superior to that of sorghum for stock feed. A comparatively new variety of nonsaccharine sorghum known as dwarf milo maize, and constituting the most important crop in the drier portions of Texas and Oklahoma, seems to possess many advantages over Kafir corn. It is possible to grow two crops a year of this important forage plant and to secure yields of grain of from 40 to 60 bushels per acre.

This grain is apparently the equal of corn for stock-feeding purposes. In the Southern States the ordinary sorghums produce larger quantities of feed than any other crop grown. They are much used for green feed in summer and for fodder. There is considerable difficulty in curing fodder for winter use, and we are investigating methods by which it can be cured without molding.

In view of the fact that there is such a wide difference in the agricultural value of the varieties of sorghum already established in this country, and in view of the fact that we have as yet only a few of the numerous varieties known to be cultivated in various parts of the world, we have undertaken to make a collection of all known varieties and to test them as forage crops throughout the country. This collection now extends into hundreds of varieties. They have thus far been grown in three States and many of them appear to possess distinct advantages over any of the kinds which are already established in this country. It will require perhaps two more years to secure sufficient seed of any of these varieties to enable us to give farmers the advantage of them.

The classification and naming of the varieties of sorghum are in charge of Mr. C. R. Ball. The study of the varieties as forage plants is in charge of Mr. C. W. Warburton.

MILLETS.

Generally speaking, the millets in cultivation in this country are used chiefly as "catch crops" for hay, when for any reason the seeding of a meadow has failed or its crop has been destroyed, or when the supply of hay is insufficient to meet the demands of the stock on the farm. In this respect millet is a most valuable crop, as it may be sown after it is too late to plant corn or some of the other standard forage crops. In some portions of the Middle West, just west of the great corn belt, millet plays an important part in the agriculture of the region, and with a great many farmers has become a standard hay crop. Owing to the fact that millet occupies a place in agriculture that often can not be filled by corn, sorghum, or any of the other forage crops, it is worthy of a wider dissemination, and with this in view a thorough investigation of the various millets grown in the different sections of this country and a study of the soil, climatic, and other conditions under which they best succeed, the most successful and practical methods of culture, etc., have been inaugurated. There is also an opportunity for improving existing varieties by standardizing them, thus making them more uniformly productive. New varieties having greater drought resistance are also much needed and are being sought.

OVERFLOWED LANDS.

The problem of utilizing land subject to annual overflow has continued to receive attention. In some cases the land can be converted into a meadow or pasture when seeded down with grasses which are adapted to such land and will withstand an overflow. It has been found, however, that where the overflow is prolonged for several weeks there is no perennial grass which will survive. In such cases it is necessary to depend upon suitable annual crops to utilize the soil

during the remainder of the season after the subsidence of the water. Experiments along the Illinois River near Pekin, where there is a prolonged annual overflow due to the presence of dams at intervals in the river and also to the water supplied through the Chicago Drainage Canal, have shown that profitable returns can be obtained from several annual crops, such as millet, corn, and sorghum sown for forage, buckwheat, and certain other crops, all of which will be reported upon at the conclusion of the experiments.

LAWN FORMATION AND MANAGEMENT.

Mr. C. R. Ball has conducted experiments, on the Department grounds, to determine the relative effectiveness of sowing different quantities of seed and of sowing at different dates. Seeds of a number of the leading lawn grasses were sown on August 15, 1903, all of which made good stands. They made fine growth during the fall months and were in excellent condition on the approach of winter. Some other sowings, made on October 27 and November 11, gave no germination until the following spring, at which time the germination was irregular, that from the latest sowing being the best. Attention has also been given to the problem of grasses suitable for shady lawns, and all the leading lawn grasses are being tested with reference to their adaptability to shady situations in this latitude. A perennial form of *Poa annua*, a very promising shade-loving grass, has been found and is being propagated for further study. It succeeds even in the dense shade of the Norway spruce, and we are now determining the rate at which it will form a satisfactory sod. Korean lawn grass (*Osterdamia matrella*), which has been recommended as a lawn grass on sandy soils near the seacoast, is now being tested for this purpose at Brookline, Mass. Observations have been made upon the rate at which small pieces of turf planted at various distances form a perfect sod. Turfs of creeping bent have covered a space twenty-eight times the size of the original in two seasons. Careful study has been made of lawns and lawn grasses in the lower New England States and along the upper Atlantic slope. It is found that redtop, creeping bent, and Rhode Island bent are the common and successful lawn grasses of that region, being especially adapted to moist soils or to those which are acid in character.

ORNAMENTAL GRASSES.

The study of ornamental grasses has been continued by Mr. C. R. Ball. The well-known perennial forms have been grouped, according to size and habit, in the formation of a beautiful and effective screen or border; their relative hardiness, different heights, and the habits which render them effective under individual use have also been determined. In addition, a large number of the so-called ornamentals among annual grasses have been grown for this purpose. Many of these have been found utterly untrue to name, in some cases seed of ordinary millet having been supplied in place of a rarer grass. But few of them are hardy enough for starting outdoors and at the same time of a habit which can be called ornamental. Some of those really valuable are the species of Briza, Chloris, Eragrostis, and Coix.

GRASS GARDEN.

The usual exhibit garden for a large number of species and varieties of grasses and forage plants has been maintained. In this are grown, for display, comparison, and study, small plats of all our commercial grasses and of species of natives the seeds of which are secured from year to year by members of the office staff and other field agents, as well as many species received from foreign sources through the Office of Seed and Plant Introduction and Distribution and other agencies.

OFFICE WORK.

The correspondence of this Office has increased rapidly during the last two years, indicating increasing interest on the part of farmers in forage problems. This is particularly the case with reference to the Southern States, especially those sections which have been invaded by the cotton boll weevil. The letters received indicate that the interest in the alfalfa crop is not confined to any particular section, but is well distributed over the eastern half of the country.

FUTURE WORK.

The plan for current work on alfalfa and clovers contemplates a careful study in the field of the soil types to which alfalfa is adapted. Special attention will be given to the relation of the acidity and moisture conditions of the soil with special reference to the cultivation of alfalfa. We are also collecting varieties of alfalfa from all parts of the world with a view to securing strains adapted to the climatic conditions prevailing in various parts of this country. A special effort will be made to extend the acreage of alfalfa in the eastern half of the United States.

We have undertaken the reclamation of a region of drifting sands along the Columbia River in Oregon. This work has just been inaugurated and will continue during the present year.

Our range investigations during the year will be devoted to a study of the stock-carrying capacity of the ranges and the methods of management followed by successful stockmen in all parts of the range region. We shall also continue the study of vegetation upon the large tract of range land under fence in Arizona with a view to ascertaining the rate at which ranges recuperate when protected from the depredations of stock. The study of the use of the cactus plant for forage will be continued. Arrangements have been made with the New Mexico experiment station for an extensive study of the distribution of the various species of cactus in that Territory and for a chemical study of the species which are utilized for forage. Arrangements have been completed for the determination of the forage value of certain species of cactus by actual trial. We shall continue the study of the forage value of certain plants adapted to alkaline soils, and shall endeavor to secure improved strains of some of the more important of these plants by separating the species as they exist into their constituent varieties. We are studying the cultural methods required to grow these salt-loving plants upon strongly alkaline soils.

Some of the standard grasses having already been separated into their constituent varieties, we are now growing the best of these varie-

ties with a view to securing as much seed from them as possible, for distribution. During the current year we shall attempt to separate other standard grasses in a similar manner.

The work of preparing monographs of American grasses will be continued as heretofore, particular attention being given those genera in which most confusion exists. We shall continue the study of herbarium material with a view to finding species of economic value, particularly for the range regions.

Cooperative work with the experiment stations will continue on the same basis as during the past year. At Arlington Farm variety tests of cowpeas, soy beans, Phaseolus, and sorghum will be continued. The more promising varieties of cowpeas and soy beans will be grown in quantities sufficient for distribution. An effort will be made to standardize the varieties of all of these crops, so that farmers may be able to secure varieties from seedsmen with definite information regarding their characteristics.

Investigations relating to the domestication of native grasses will continue on a somewhat larger scale than in the past year. Seeds of the most promising grasses are being secured in the field, and these will be distributed to farmers in localities favorable to their cultivation with a view to studying them under farm conditions. Particular attention will be paid during the coming year to winter-growing grasses and legumes for pasture and forage purposes in the Southern States. We shall continue to glean the experience of southern farmers with plants of this character and shall particularly endeavor to extend the cultivation of the winter variety of the common spring vetch. The investigation of forage crops adapted to the Gulf coast region will be extended. Forty-two varieties of cassava will be studied with reference to their adaptability to soils and climate and the best methods of propagation. Extensive experiments will be continued on methods of keeping cassava canes during the winter and of securing a perfect stand of cassava in the field. Investigations of Guinea grass and Para grass for hay and pasture purposes in southern Florida having been instituted, during the coming year we shall undertake to determine the feasibility of securing a stand of these grasses from seed. On the Pacific coast the study of forage plants adapted for growth on land that is at present summer-fallowed each alternate year will be continued. We shall also continue the introduction of certain species of grasses which have shown their adaptability to dry lands in that section of country.

During the current year extensive tests will be made of machinery adapted to removing the rootstocks of Johnson grass and similar grasses from the soil. Demonstrations will be made in several States of methods developed by this office for destroying this pest. A further study will be made of numerous varieties of saccharine and non-saccharine sorghums particularly with reference to their adaptability to the cotton-growing States and to the western edge of the humid region. We shall attempt to secure a quantity of seed of some of the best grasses adapted to growing on wet or overflowed lands and to grow these grasses under experimental conditions.

A new grass garden will be laid out because of the necessity of abandoning the old one on account of the construction of the new buildings of this Department. The plan of the garden will be changed

with a view to making it more instructive in character as well as more ornamental.

POMOLOGICAL INVESTIGATIONS.

Fruit growing, an industry representing a national investment of more than $300,000,000, has received increased attention from the Departmental scientific corps in charge of this branch of work. The Office of the Pomologist, under Col. G. B. Brackett, has pushed its investigations with vigor. During the year 44 official trips have been made, 13,000 letters written, and 325,178 copies of pomological publications distributed; 7 experimental vineyards have been established; the experiments in the cold storage of small fruits have been continued, and partial investigations of the shipping and storage of citrous fruits and also of the peach and pecan industries have been conducted.

The various lines of pomological investigation involving field work, in distinction from those chiefly confined to the city of Washington, have continued under the direction of Mr. William A. Taylor, pomologist in charge. These are grouped under the following heads: (1) Fruit Marketing; (2) Fruit Storage; (3) Viticultural Investigations; (4) Fruit District Investigations; (5) Miscellaneous Field Problems.

FRUIT MARKETING.

The work under the head of fruit marketing has been directed jointly by the pomologist in charge and Mr. G. Harold Powell, being in many of its phases closely related to the fruit-storage work. Attention has been paid chiefly to problems having special bearing on the development of export trade in fruits, with a view both to introducing American fruits to markets that have not previously taken them in commercial quantities and to enlarging present markets by devising and encouraging the practice of methods of handling that will insure delivery of our fruits to foreign consumers in better condition than has generally been the case heretofore. While the former phase of the work is perhaps the more spectacular and striking in its immediate results, the latter is probably the more important in its ultimate effect and deserving of the greater attention given it because of the wider diffusion among growers of the benefits resulting therefrom through increase in demand for their products.

It is difficult to determine with accuracy what influence the experimental investigations made by the Department along these lines have had on the increase in fruit exports during the past three years, but certain features are clearly traceable to this work and indicate its practical value. One of these is the gratifying development of the export trade in Bartlett and some other early pears from the Eastern States during the shipping season of 1903. According to commercial estimates some 75,000 packages of such pears, mostly grown in New York and New Jersey, were exported during the season as a direct result of the cooperative experimental shipments made by the Department in 1901 and 1902, through which the methods best adapted to the exportation of such fruit were determined. Including the later varieties, a total of about 165 carloads of eastern-grown pears went across the Atlantic in 1903. The importance to the fruit industry of this country of the profitable exportation of this quantity, which is but a fraction of the total pear crop, is not measured so much by its actual

volume as by the fact that by this means an otherwise troublesome surplus of perishable fruit is removed from domestic markets, thus lessening the danger of such disastrous gluts as have often been experienced in the past. The export trade in this fruit may now be considered safely established and may be left to develop naturally under the law of supply and demand, which ultimately determines the stability of all export trade.

Another gratifying feature of the year's work has been the rapid development of winter apple shipments to France. In former years shipments to that country have been desultory and irregular, with no steady or important demand resulting therefrom. The attention drawn to American apples by the fruit exhibit of the United States at the Paris Exposition in 1900, which was made under the direction of the Pomologist, reenforced by a series of cooperative shipments made direct to Paris in the season of 1902–3, resulted, according to commercial estimates, in the direct shipment of about 200 carloads of apples from the United States to France during the shipping season just ended. This quantity is about twelve times as great as the average of the past five years, and the prices realized are understood to have been very satisfactory to shippers.

Experimental shipments of peaches from Georgia were made under disadvantageous circumstances, owing to heavy rains preceding and during the shipping season, which resulted in a crop of fruit of poor carrying quality. Such seasons are likely to occur occasionally and to interfere more or less with the development of this trade. It is believed, however, that by drawing upon regions farther west, such as the rapidly developing peach regions of Texas, Indian Territory, Oklahoma, Arkansas, and Missouri, in such years, an annual supply can be secured sufficient to meet any trans-Atlantic demand that may develop.

A shipment in August, 1903, of Elberta peaches from Oklahoma to Liverpool, via New York, reached its destination in excellent condition and sold at prices that were highly satisfactory to the shipper, realizing $2.16 net per six-basket carrier on dock in New York.

The point of chief importance to prospective exporters of peaches at this time is the determination of the quantity of fruit that can be taken by foreign markets at remunerative prices during the months of July, August, and September, when the important commercial varieties of this fruit mature in succession from Georgia and Texas northward to Connecticut, New York, and Michigan and westward to Colorado and California. This phase of the question needs thorough investigation in foreign markets, particularly those of the United Kingdom.

A series of cooperative shipping tests from Georgia to domestic markets demonstrated that on choice fruit in carload lots a suitable paper wrapper frequently adds to the selling price more than double the cost of paper and additional labor, even when the fruit is purchased for immediate use rather than for storage.

A series of cooperative shipments of summer apples from Delaware during July and early August confirmed the indications of the previous year that in seasons when the European crop of early summer fruits is light, such varieties as Randolph, Early Strawberry, and Williams can be very profitably exported from our Middle Atlantic States, while with the earlier and more delicate varieties, like July, Red Astrachan, and Yellow Transparent, there is a fair chance for profit,

though the difficulty of delivering them sound is much greater and the risk correspondingly increased. A few commercial shipments of such fruit were made to British markets in 1903, and the indications are that whenever market conditions are favorable a considerable development along this line will occur in certain localities. The essentials appear to be suitable fruit, ripening during July and early August conveniently near to railroad and transportation facilities that will insure quick delivery of the packed fruit at point of export.

The most important work of the year consisted in packing and forwarding a series of shipments of staple varieties of winter apples to various European markets to test the relative merit of the box and the barrel as packages for the export shipment of those ordinary grades of fruit which constitute the great bulk of our apple-export trade.

In these shipments care was taken to have the fruit of uniform grade and pack, in order that all other factors than the size of package and the effect of wrapping might be eliminated. The average results obtained on these shipments do not disclose any marked advantage to the shipper in the use of the box rather than the barrel for unwrapped fruit of average grades in the leading foreign markets. In this connection several important points need further investigation during the coming year.

FRUIT STORAGE.

The fruit-storage investigations have been continued under the direction of Mr. G. Harold Powell, pomologist in charge, assisted by Mr. S. H. Fulton, assistant pomologist. The investigations are clearing up many of the practical fruit-storage difficulties and are helping to establish better methods for the successful storage of fruits when grown under different conditions of soil, climate, location, and orchard management and when harvested, stored, and shipped under the commercial conditions that obtain in the different regions. They have included the apple, pear, peach, and the principal small fruits, and have been conducted during the year in warehouses in Chicago, Ill., Buffalo, N. Y., Jersey City, N. J., Washington, D. C., and in various laboratories in the Department of Agriculture.

From the cultural standpoint the experiments of the year have confirmed the results of former years and appear to show that fruit produced on trees forced in growth, on young, rapidly growing trees, or on light, quick-acting soils has poorer keeping quality than the same variety grown more slowly. As examples, York Imperial, Ben Davis, Winesap, Pound Sweet, and Hubbardston apples from young trees have broken down from two to four months earlier in a warehouse than fruit from older trees under identical storage conditions.

From the standpoint of the fruit handler the experiments appear to show that apples and peaches should be of full size and highly colored, but hard, when picked to insure best keeping quality. Immature fruit is likely to shrivel if stored. It lacks quality, and apples picked in this condition have proved more susceptible to "scald" in storage.

A large proportion of the practical difficulties in the cold storage of apples is caused by delay in placing the fruit in storage after it is picked. The investigations, as in former years, show conclusively that the fruit ripens rapidly and that diseases spread quickly if the fruit is not stored soon after picking. Such delay often causes winter

apples to decay several months earlier than when stored immediately after picking.

As a result of some preliminary studies, the investigations indicate also that many of the losses in the transportation of perishable fruits, like the peach, are caused by the ripening of the fruit and the spread of diseases that take place before the fruit is cooled by the ice in the refrigerator cars in which it is forwarded to market. The cooling of the fruit to a temperature of about 40° F. before it is loaded in the cars greatly improves its carrying quality by retarding the ripening processes and the development of diseases.

A preliminary investigation has been made of the causes of the losses in the storage and transportation of the citrous fruits of California, with a view to beginning experimental work along these lines during the coming fiscal year.

VITICULTURAL INVESTIGATIONS.

This important line of investigation has continued under the personal direction of Mr. George C. Husmann, viticulturist in charge. As noted in the report for 1903, the condition of the viticultural industry on the Pacific Slope, as stated by the growers and verified by the viticulturist through thorough investigation of the more important viticultural sections, renders imperative the prompt and comprehensive investigation of the difficulties that threaten the industry. It is estimated that at least 75,000 acres of vineyard have already been destroyed by vine diseases, phylloxera, and other agencies still in operation, causing a direct loss of at least $50,000,000 to the industry. To afford relief to these conditions and endeavor to restore the industry to a safe and profitable basis, the following specific lines of work are under way:

(1) A comprehensive test of the resistant stock varieties of vines, to determine their adaptability to the different vineyard soils and climatic conditions of the Pacific Slope.

(2) The determination of the congeniality of the leading Vinifera varieties to the leading resistant stocks.

(3) The determination of the adaptability of varieties to the conditions existing in different vineyard sections.

(4) A comprehensive test of all classes of grapes with reference to their resistance to a disease which has been doing serious injury to the vineyards, and, if found necessary, the creation of an entirely new class of grapes better adapted to Pacific Coast conditions.

In cooperation with the Office of Seed and Plant Introduction and Distribution, two experimental vineyards were established last year—one at Oakville, Napa County, Cal., in one of the leading wine-producing districts; the other near Fresno, Fresno County, Cal., in the leading raisin-producing section. At each of these points about 4½ acres were planted, some seventy varieties of resistant stock being used. During the present year these vineyards have been enlarged, so that the one at Oakville now contains about 10 acres, including 179 resistant varieties and 57 Vinifera varieties on resistant stocks, and the Fresno vineyard, 6 acres, including 155 resistant varieties. In view of the entirely different conditions south of the Tehachapi Pass, especially in the desert region, a third experimental vineyard of like importance has been located at Cucamonga, San Bernardino County,

Cal., and plantings of 8.4 acres, comprising about 400 varieties, nearly all Viniferas, have been made. As phylloxera is not troublesome there, this planting consists almost entirely of nonresistant varieties.

These three vineyards are intended to afford facilities for broad viticultural research, involving the introduction of vines from all parts of the globe, and are to serve not only as practical object lessons to vineyardists, but also to afford standards by which to correct the nomenclature of grape varieties, now considerably confused. Some interesting and important data on the relative varietal endurance of excessive irrigation and subirrigation have already been obtained at the Fresno vineyard.

Smaller outlying experimental vineyards for testing varieties under other conditions than those represented in the three principal vineyards—such as gravelly, clayey, sandy, shallow, and hillside soils, higher and lower altitudes, and the diverse climatic conditions caused by nearness to and distance from the ocean and other bodies of water—were located and plantings made in them, as follows:

Concord, Contra Costa County, Cal., 1¼ acres; 84 varieties.
Geyserville, Sonoma County, Cal., ⅝ acre; 73 varieties.
Livermore, Alameda County, Cal., 1 acre; 72 varieties.
Lodi, San Joaquin County, Cal., 1¼ acres; 68 varieties.
Mountain View, Santa Clara County, Cal., 1¼ acres; 79 varieties.
Sonoma, Sonoma County, Cal., 1.1 acres; 72 varieties.

The plantings in all the vineyards are limited at present to resistant vines and direct producers.

Considerable distribution of Vinifera and resistant vines and cuttings to individual experimenters has been made, and detailed descriptions of the fruit of numerous grape varieties have been added to the office files. Additions are being made from time to time to the ampelographical index. Trips of investigation have been made during the year on both the Pacific and Atlantic slopes with a view to determine the exact conditions and to shape future systematic work. Correspondence with persons desiring information on different phases of grape growing and the manipulation and marketing of the products of the grape is increasing very rapidly.

On the Atlantic Coast the Scuppernong type and the commercial possibilities of its production have been looked into with a view to beginning systematic work in the improvement of this promising native species for the South. It has been found to thrive on soils of little value for other crops, of which it is estimated there are 3,000,000 acres available under suitable climatic conditions. Rot, mildew, and anthracnose, so detrimental to other vines in the South, seem to injure this species but little, and some of the best results thus far have been attained with unpruned and uncultivated vines. While in flavor and quality the Scuppernong grape is not equal to the improved varieties of several other native species at this time, those who are accustomed to the fruit think highly of it for dessert use. It also makes excellent pie fruit, and superior dry and sparkling wines have been made from it.

The experimental vineyards at Earleton, Fla., and Southern Pines, N. C., were continued. At Earleton warm weather continued exceptionally late in the autumn of 1903, causing the vines to make a new growth in November. Late in that month a sudden cold spell, during which the thermometer fell to 26° F. on November 26, 20° F. on the

27th, and 26° F. on the 28th, so chilled the vines that serious injury to the canes resulted. Heavy cutting back of young wood was resorted to, and the vines have since made a good new growth. The climatic changes in Florida make it necessary to employ methods of pruning, training, and cultivating which are different from those practiced in other States. At Southern Pines the conclusions of last year have been verified that certain Vinifera varieties grafted on resistant stocks when given the same treatment as is needed for American varieties will produce as much or more fruit and of superior quality.

FRUIT DISTRICT INVESTIGATIONS.

Work in fruit district investigations has continued under the direction of Mr. H. P. Gould, assistant pomologist in charge. Because of the complex character of these investigations and the multiplicity of the problems involved, the report at this time upon the status of the work is one of progress rather than of specific results accomplished.

For the third consecutive season the phenological work previously reported upon has been continued. About 700 fruit growers, covering in their locations the most important fruit-growing sections of the country, are cooperating in this work. Several large trial orchards, as well as commercial plantations, have been placed at the disposal of the Department for this investigation and are under observation by some member of the scientific staff for a portion of each year. In this connection several problems are being considered with special reference to the influence of elevations, temperature, etc., upon the seasonal epochs in the life history of the peach.

The study of the early apple districts of Delaware and southern New Jersey, which was begun in 1903, has received further attention through supplemental observations upon the behavior of the more important varieties, more detailed study of the conditions under which they were grown, and a general review of the early apple industry in this territory. It is expected that a report for publication upon this interesting industry will be possible in the near future.

The work in the Piedmont and mountain areas of Virginia, North Carolina, South Carolina, and northwestern Georgia has been continued along the same lines as previously reported. The great diversity of soil, elevation, slope, and climate in these areas, with the variations incidental to these fundamental factors, make the problems exceedingly complicated and difficult of solution; but repeated observations in certain representative orchards within the territory concerned are throwing much light upon the points under consideration. These areas include a large amount of land which can doubtless be devoted to fruit raising with greater profit than to any other purpose if a proper selection of varieties can be made and intelligent care given to the orchards and crops. There are also to be found within this region, especially in the mountain portion, many local varieties, particularly of apples, and unnamed seedlings of undoubted merit which are unknown outside the immediate neighborhoods wherein they are growing. It is hoped that more attention can be given to these features in the future than has been possible thus far.

MISCELLANEOUS FIELD PROBLEMS.

Under the head of miscellaneous field problems the subjects that have received special attention during the year have been the continuation of the field study of the pecan industry in Mississippi, Louisiana, and Texas, the continuation of systematic work on the peach, and the beginning of a systematic study of small fruit culture, upon all of which subjects publications are in preparation.

PLANS FOR FUTURE WORK.

FRUIT MARKETING.

During the fiscal year ending June 30, 1905, it is proposed to continue cooperative experimental export shipments of summer apples in the expectation that European market conditions will be somewhat less favorable than during the past two years, both because of the prospective large crop of summer fruits in Great Britain and on the Continent, and the surplus of Australasian apples that is likely to be encountered as the result of unusually heavy shipments from Tasmania, Australia, and New Zealand during April and May, 1904. Several types of boxes will be tested in these shipments. Further work is contemplated in shipping the peach from points as far south as southern Georgia, and continuing the shipments from points as far north as suitable fruit can be obtained. Tests of cooling peaches before loading for shipment are also contemplated to determine the effect of such cooling on the durability of fruit thus treated, both when shipped in refrigerator cars and when shipped relatively short distances by express without refrigeration in the ordinary way practiced by small shippers.

Investigation of packages and methods of packing winter apples for export shipment will also be continued in a systematic way, with special reference to the conditions that prevail in the various apple districts regarding labor, packages, etc.; and it is hoped that a systematic investigation of methods of cooperative packing and handling of fruits in vogue in different districts, which was unavoidably postponed last year, can be made.

FRUIT STORAGE.

The following lines of investigations under the head of fruit storage are contemplated:

(1) The continuation and extension of the investigation of the influence of cultural conditions on the keeping of fruits.

(2) The continuation and extension of the investigation of the influence of commercial methods of picking, handling, and storing on the keeping quality of fruits.

(3) The continuation and extension of the study of the causes of losses in peaches in transportation in refrigerator cars.

(4) The investigation of the causes of losses in the storage and transportation of citrous fruits from the Pacific Coast.

(5) The continuation of the investigation of the development of fruit fungi in different storage temperatures, in cooperation with the Pathologist and Physiologist.

(6) The continuation of the investigation of chemical changes in storage fruit, in cooperation with the Bureau of Chemistry.

VITICULTURAL INVESTIGATIONS.

The viticultural investigations previously noted as under way in California will be continued and additional plantings will be made. At Oakville and Fresno the earlier plantings are expected to make sufficient growth this season to permit the beginning of systematic grafting experiments in the spring of 1905 in order to study the behavior of the stocks when grafted and the congeniality of the leading commercial varieties of grapes grown for various purposes to the different resistant stocks. Observations on the relative growth and merits of resistant varieties on different soils and under different climatic and other conditions, as well as studies in wood and bud selections and in the pruning of a number of varieties will be made.

A nursery test of the relative rooting qualities of different resistant varieties to test their commercial value as stocks is contemplated.

Extensive studies in the commercial vineyards of the Pacific Coast will be made. As much field investigation as possible of vineyard districts in different parts of the United States will be undertaken to determine their needs and to aid in the general improvement and development of the industry.

A special investigation of the Scuppernong grape (*Vitis rotundifolia*), the character and value of its products, improvements possible in its culture, training, and marketing, and a systematic search for choice varieties that may have hitherto escaped observation are contemplated.

Studies of the Vinifera varieties on the Atlantic Coast will be continued.

Practical bulletins on viticultural subjects, to meet the constantly increasing requests for information along these lines, are contemplated.

FRUIT DISTRICT INVESTIGATIONS.

The preliminary survey of the Ozark region of Missouri and Arkansas, which was begun last season, is to be continued with increased attention to details of soil, climate, and other influencing factors, and to the behavior of the different varieties under these conditions. Apples and peaches will be the principal fruits studied. Although it will not be possible to complete these observations this season, material progress may be expected.

The display of cold-storage apples of last season's crop at the Louisiana Purchase Exposition offers an unusual opportunity for studying the variations of particular varieties from different sections of the country, as this exhibit has brought together specimens of many varieties from widely separated points, thus making careful comparisons possible. While the means at hand for determining in detail the actual conditions under which the fruit was grown are rather unsatisfactory, the manifestation of those conditions in the variations of the fruit itself offers an interesting and valuable field of study, which will be improved so far as time will permit.

The plans for future work include the completion, as rapidly as possible, of the investigations already under way, and the extension of similar studies to other important fruit-growing sections. With increased

facilities and prospective assistance in this work, more rapid advancement is expected for the future than has been possible heretofore.

HORTICULTURAL INVESTIGATIONS.

GARDENS AND GROUNDS.

The proposed location of one wing of the new Departmental buildings on land used for greenhouse and garden purposes by the Office of Gardens and Grounds has necessitated many alterations. Some of these have been referred to under other headings. All of the conservatories and greenhouses now on the south side of the grounds will eventually have to be moved. Most of the material in these greenhouses is useless for further greenhouse work. Some of it, however, can be used, and will be taken to the Arlington Farm and utilized there in the construction of greenhouses for experimental purposes. About one-half of the glass area now devoted to plant work can stand for the present, as it will not be in the way of the new construction work.

WORK ON GREENHOUSE AND OTHER CROPS.

Carnations.—The commercial importance of the carnation places the improvement in varieties, both as regards habit of growth and character of bloom, together with the improvement in cultural methods, among the most important practical problems for the experimenter. While our facilities up to the present have not permitted extensive efforts along these lines, there are now growing in the houses of the Department 163 seedlings which are the result of careful cross-pollination of varieties showing most promise, both in habit of growth and in type of bloom. While we realize that this is in large measure a question of chance, we appreciate that a decided acquisition in this line is worth to the trade many times the cost of the effort.

The plan of growing carnations upon the bench throughout the season has again been followed with good success during the current year. The plan of never growing the carnations outdoors will, we believe, prove more satisfactory for the commercial growers than the outdoor plan usually followed. While this scheme requires the use of a house throughout the entire year, it nevertheless overcomes the great shock to which the plants are subjected in lifting them in the autumn, and results in a very much larger and earlier yield of flowers. The scheme is specially adapted to the use of those who wish to produce flowers for the Holiday trade.

Chrysanthemums.—A chrysanthemum exhibit, made up chiefly from standard commercial sorts grown as bush plants, carrying from 10 to 30 blooms, and from novel and amateur varieties, was again held during the closing days of October and the first days of November, 1903. The exhibit contained many sorts not to be found in commercial collections, and in this respect it was noteworthy from an educational standpoint. The variety list this year consisted of 132 named sorts, besides a number of unnamed seedlings. The beauty and usefulness of specimen plants trained in bush form are not sufficiently appreciated by our people. The exhibition of plants grown in this form in contrast with single-stem plants can not but appeal to the better judgment of the flower-loving public, and we believe that the educational value of such

object lessons far exceeds their cost. That the people of the city enjoy and appreciate these efforts is amply demonstrated by the attendance.

LILIES.—The work on the improvement of lilies for forcing has been continued by Mr. George W. Oliver. The results secured in growing the lilies from seed have been referred to in former reports. Further work along this line has demonstrated the feasibility of growing, in one year from seed, lilies of large size and capable of supporting from 8 to 12 and as high as 14 fine flowers. Seedlings handled by Mr. Oliver's methods, moreover, have been very vigorous, showing little or no evidence of disease. Plants 7 feet in height have been produced in eleven months from seed. Considerable quantities of seed have been secured as the result of crossing, and this seed has been distributed in different parts of the country for experimental purposes. A portion of the seed was sent to Santa Ana, Cal., where the lilies grown therefrom were planted by Mr. Newton B. Pierce in accordance with specific directions. In twenty months from planting, these seeds have given large, vigorous bulbs, many of them producing from 8 to 12 flowers.

LETTUCE AND LETTUCE IMPROVEMENT.—During the year Mr. Oliver has carried on, under the direction of the Chief of Bureau, some work on the hybridizing of lettuce. There has been little accomplished in late years in the matter of producing new lettuces, and such as have been produced are all the result of ordinary field variations, of which advantage has been taken. So far as known, no attempts have ever been made to hybridize lettuces. A number of hybrids which are very promising in value have been secured. The object of this work has been to secure types of lettuce suitable chiefly for cultivation under glass. The demands of the market are such as to require (1) a lettuce of good heading quality, (2) a lettuce having light-yellow leaves and giving a white head, and (3) a lettuce that does not succumb readily to scald or top-burn. By combining certain characteristics in the different types now in existence it is believed that these results will be secured.

HYBRIDIZING CLOVERS AND GRASSES.—Mr. Oliver, under the direction of the Chief of Bureau, is also carrying on work having as its object to secure, if possible, hybrids between some of the more desirable clovers and grasses. This is new work, but already several successful hybrids have been secured. Hybrids are being made between the different clovers, different varieties of cowpeas, soy beans, and various other forage crops, and also between a number of different grasses.

SCHOOL-GARDEN WORK.

During the early spring a brief circular giving plans for school gardens, together with cultural suggestions upon the list of flowers and vegetables recommended for use in these gardens, was prepared by Prof. L. C. Corbett, Horticulturist. This publication was sent only to those teachers and pupils who requested seeds for the purpose of instruction. Sets of seeds conforming to the plans provided in the circular were assembled and distributed upon request only.

The work this year required 5,857 sets of six packets each of vegetable seeds and 6,825 sets of seven packets each of flower seeds, or a total of 12,682 packages containing 82,917 packets. In addition to

these, 1,223 packages of flower seed, 733 packages of vegetable seeds, and 496 packages of miscellaneous grains were furnished to the schools.

With a view to encouraging school-garden work in Washington, cooperation was continued again this year with the school authorities of the city. Under the direction of Miss Susan B. Sipe, the normal school of Washington has been carrying on extensive work in the improvement of school yards, the encouragement of school gardens, and general work in horticulture. Facilities for school-garden work have been afforded on the Department grounds, where a number of gardens have been planted and handled by school children, under the direction of Miss Sipe. Eighty-five normal school girls have been taking instruction under Miss Sipe in general horticulture, and facilities for their work are also accorded on the grounds. To further this work Miss Sipe has been made a collaborator of the Bureau, and is now engaged in making studies of the different systems of school-garden work in various parts of the country. A report on this subject will be issued.

PLANTS PROPAGATED AND DISTRIBUTED.

During the year there were propagated and distributed under the direction of Mr. Edwin M. Byrnes, the superintendent of the grounds, 198,000 plants, representing 50 different species and varieties.

COOPERATIVE WORK.

As was noted in the last annual report, one house of the range of houses belonging to Gardens and Grounds was turned over to the Pathologist and Physiologist, and has since been devoted to the growth of plants for the purpose of studying their physiological and pathological conditions. This house is called the "plant infirmary." The cooperative work between Gardens and Grounds and the Office of Seed and Plant Introduction and Distribution has this season taken the form of cultivating upon the grounds an extensive collection of annual flowering plants, including not only the common garden annuals grown from seeds, but an extensive collection of bulbs, and many novel and standard sorts of the tulip, narcissus, and hyacinth. This work is, as has been before noted, for the purpose of studying the fitness of these various plants for the seed distribution and the educational value which will come from having such a collection in a position where the visiting public can inspect and study it.

NEEDED IMPROVEMENTS ON DEPARTMENT GROUNDS.

The changes necessitated in connection with the plans of the new buildings call for the alteration of some of the plantations upon the grounds. New trees and groups of shrubs should be provided to give the place a finished appearance as soon as the grading and building in any part is completed.

The loss by winterkilling and other causes of several of the valuable evergreens from prominent groups upon the grounds renders the reestablishment of these specimens desirable both from the standpoint of beauty and the desirability of maintaining the species.

The gravel roads which it seems to have been the policy to maintain through the Mall are being subjected to very rough usage, and those through the grounds of the Department will require resurfacing as

soon as the heavy traffic ceases. Even those which are not given rough usage need a coat of gravel or crushed rock in order to render them worthy of the name of gravel drives.

ECONOMIC HOUSE.

The new range of greenhouses which was provided for at the last session of Congress only partially meets the needs of the Bureau in this line. It is desirable that the present range of eight houses be extended to complete the block provided for by the potting shed; and were this done the demand for space required by the rapidly expanding work in plant pathology and physiology and that in plant introduction and propagation would not be more than met. Even with this there would be no shelter provided for the valuable collection of economic plants. An economic house of suitable type for housing the plants now stored in the old conservatories, which must soon be torn down, is greatly needed. The collection is too valuable to destroy, and it does not seem wise to allow it to be removed from the immediate vicinity of the Department of Agriculture, where students, as well as the public, have a right to expect to find such a collection.

PLANS FOR FUTURE WORK.

The moving of the greenhouses will necessarily increase the expense of the work, as the force will, for a time, have to be divided. The placing of the new houses in the northwest corner of the grounds will also necessitate certain changes in the plantings. The northern portion of the Department grounds has always been low, and at certain seasons the water sometimes overflowed it. To obviate this difficulty about one-fifth of this portion of the grounds has been filled in with soil obtained from the excavations connected with the construction of the new National Museum building. It is planned to establish on this raised ground gardens containing complete collections of various ornamental and other plants. The space occupied by the new greenhouses will be screened by a collection of the best hardy evergreens. Full collections of peonies and bulbous and other plants will also be put in. Plans are also being made for the establishment of an instructive grass garden in this portion of the grounds. As rapidly as practicable all the trees, shrubs, etc., will be labeled. The new greenhouses will be devoted to the various needs of the Bureau and of the Department. One of the old houses will, for a time, be assigned to the use of the Bureau of Soils and another will be devoted to experimental work with the new boll-weevil ant. Others will be used, as already indicated, for the work being conducted by the Office of the Pathologist and Physiologist. The seed and plant introduction work will require several houses. It is planned to begin at an early date some extensive work on the growing of plants under glass.

THE ARLINGTON EXPERIMENTAL FARM.

The work at the Arlington Farm has been, as heretofore, under the direction of Prof. L. C. Corbett, Horticulturist. A brief statement of the results accomplished follows.

SOIL IMPROVEMENT.

The work of ameliorating and improving the soil is one of the most important undertakings in connection with building up the Arlington Farm.

In addition to the general policy of at all times keeping the soil covered with a growing crop—cowpeas or rye—when the land is not in commission for experimental use, an attempt is being made to lower the water table and at the same time to deepen the seed bed by subsoiling. While it is yet too early to judge the merits of this system of cultivation, hope is entertained that it will prove of value in connection with a thorough system of tile drainage.

NURSERY WORK.

From the nature of the work, a nursery must change markedly from season to season. The oaks and ashes which last season were a marked feature of the nursery have this year given place to a large plantation of mulberries. The following inventory gives an idea of the extent and variety of this work:

Economic fruits.

Apple	2,618	Cherry (various sorts)	207
Pear	38	Grapes (various sorts)	1,600
Pear, seedling hybrid (Waite's)	2,400	Currants (various sorts)	133
Peach (various sorts)	175	Blackberries (various sorts)	130
Plum (various sorts)	30	Raspberries (various sorts)	65
Almond (various sorts)	10		
Apricot (various sorts)	147	Total	7,555
Nectarine (various sorts)	2		

Stocks.

French apple	50	Peach (mixed)	2,500
Western apple	750	Peach (North Carolina)	1,500
Dwarf apple	25	Plum	250
French pear	75	Cherry	300
Kieffer pear (seedlings)	75		
Quince	200	Total	11,725
Peach (native)	6,000		

Ornamental trees.

Silver maple	1,500	Zelkova crenata	300
Sycamore maple	400	Cytisus laburnum	50
Norway maple	1,200	Colutae arborescens	45
Fraxinus excelsior	75	Citrus trifoliata	500
Fraxinus viridis	200	Juglans nigra	600
Tilia americana	500	Juglans regia	1,000
Magnolia acuminata	50	Juglans rupestris × nigra	200
Cladrastria tinctoria	50	Taxodium	500
Celtis occidentalis	100	Horse-chestnut	100
Liriodendron tulipifera	1,500	European hornbeam	250
Platinus occidentalis	100	Larch	60
Platinus orientalis	40	Ginkgo	1,000
Catalpa speciosa	1,000	Pecan	1,000
Gymnocladis canadensis	175	Lilac	1,000
Ulmus americana	600	Mulberry (1-year plants)	10,000
Quercus laurifolia	200	Mulberry cuttings	10,000
Quercus hindsii	15	Mulberry seedlings	50,000
Quercus coccinea	30	Privet (2-year plants)	1,000
Quercus pedunculata	520	Privet cuttings	25,000
Quercus palustris	1,000	Japan quince seedlings	200
Betula alba	200		
Sophora japonica	950	Total	113,210

VEGETABLE GARDENING.

The home vegetable garden, which is being conducted as a counterpart of and adjunct to the one-acre fruit garden, was this year increased to one acre in extent. An account is being kept of the product of this acre to determine its value as a means of meeting the expense of a family.

The vegetable testing grounds conducted by the Office of Seed and Plant Introduction and Distribution, which for several years past have been maintained on the Potomac Flats, were this season transferred to the farm. About four acres are devoted to this important branch of the work. The soil of the farm is typical of a vast area east of the Allegheny Mountains and south of the terminal moraines, and is therefore better suited for crop work and variety testing than the pumped-in soil of the Flats, which is neither river deposit nor sedentary soil, but a rich river mud characteristic of no agricultural region of the Eastern States.

SWEET POTATO TESTS.

The variety collection of sweet potatoes brought together some time ago, and which has for two years been grown upon the Flats for the purpose of comparing types and making variety descriptions, has been replanted this season. This is one of the most extensive and most authentic variety collections of sweet potatoes in the United States, and affords a valuable source from which to supply stock for cooperative work.

WHITE OR IRISH POTATOES.

For three years a collection of some seventy varieties of Irish potatoes has been grown upon the Arlington Farm. This season the test is unusually good, and the work for which the collection has been prepared will, at the close of this season, be undertaken, i. e., the study of the potato areas of the United States with reference to the distribution of varieties and the production of tubers of superlative merit for special purposes. Disease-resistant strains are being tested as well as bred, in the hope that much of the loss now occasioned by blight and rots may be overcome.

CELERY TESTS.

The cause of pithiness in celery has long been a puzzle to both growers and seedsmen, and in many instances this pithiness has been the ruin of promising crops, entailing heavy losses upon the grower and bringing, justly or unjustly, severe criticisms upon the seedsmen. One of the chief objects of the cultural and variety tests with celery now under way is to throw light upon this important problem. The cultural work also involves a test of different methods for mechanically distributing water over celery plantations. Nozzles of various kinds are in use to distribute water from a steam pump through temporary pipes placed over the area to be irrigated.

SHADE WORK.

The cultivation of various plants in modified light by placing cloth and slat shades or tents over the area occupied by the crop has for several years engaged the attention of various scientific as well as practical plant culturists. This line of endeavor was taken up by the Depart-

ment several years ago in connection with the studies upon tobacco and later extended to vegetables. Up to the present season this work has been conducted at the Flats, but this year it was transferred to the farm, where it can receive more careful personal attention. This work presents a number of interesting problems in plant cultivation, as well as in plant physiology, and these fundamental problems rather than the economic phases of shade work are now under investigation.

COOPERATIVE WORK.

The cooperative work with the Office of Vegetable Pathological and Physiological Investigations covering field work with soil bacteria and field tests of sugar beets and field corn is again being carried on.

With the Agrostologist the work comprises an extensive list of forage crops, to which some ten acres of land are this year devoted.

The vegetable tests with the Office of Seed and Plant Introduction and Distribution have already been mentioned.

The total area devoted to the work of the associated offices of the Bureau at the Arlington Farm consists of some 33 acres.

PERMANENT PLANTATIONS.

In addition to the experimental orchard and fruit garden mentioned in the last annual report, the permanent plantings of the place have been extended by the addition of a section containing a somewhat limited variety collection of apples, pears, quinces, peaches, cherries, and plums—in all some 479 trees.

A second section of 155 trees entirely devoted to apples has been planted. The object of this area is to afford facilities for studying the effects of the continuous use of certain cover crops upon the soil conditions as well as upon the growth of the trees.

A third orchard area is given up to a variety collection of peaches comprising 152 sorts. This variety collection has the merit of having been "made to order," as it were. The stocks were grown from pits selected from seedling mountain trees and the buds were taken from bearing orchard trees. Three specimens of each variety were placed in the orchard, making 456 trees in all. In connection with this plantation there has been put out a miscellaneous collection of cherries, apricots, peaches, and almonds imported by the Office of Seed and Plant Introduction and Distribution.

ORNAMENTAL PLANTING.

The house lot, which is designed to afford space for all the permanent buildings of the place, can not yet be said to have assumed any very definite form, but plans have been evolved for its development, three buildings erected, and a few trees planted. A row of willow oaks (*Quercus phellos*) has been planted on either side of the main entrance, extending from the front of the Arlington National Cemetery to the house lot, a distance of about 1,500 feet.

PERMANENT IMPROVEMENTS.

The facilities of the farm have been improved during the year by the erection of two cottages, each having seven rooms and a hall. Each house has a cellar under the entire building and has brick walls

for one story and shingles on the second story and gables. They are also provided with water from a general supply, and have bath and sewer connections. This equipment was installed not simply for sanitary reasons, but because we believe that every farmhouse can be provided with these conveniences as satisfactorily and as cheaply as can a city house.

WATER SUPPLY.

The water supply for the farm is obtained by concentrating the flow from the famous Custis Spring into a reservoir holding about 200 barrels, from which the water is pumped into a supply tank situated in the third story of the barn and from there distributed by gravity to the several stations on the farm.

SEWER SYSTEM.

A trunk sewer has been laid and connection made with each of the houses. This is intended to care for the water from the downspouts as well as the drainage from the houses.

SILO.

A tank silo 12 feet in diameter and 22 feet high affords storage for about 50 tons of silage.

TEAMS, TOOLS, AND IMPLEMENTS.

The number of horses at the place has not been increased during the year. New implements have been purchased to increase the efficiency of the team service as well as of cultivation and to meet the requirements of special lines of work.

Power for operating machinery has been installed. An 8-horsepower gasoline engine located in the basement story of the barn provides power for operating a 28-inch cylinder thrashing machine, a feed cutter for filling the silo and for cutting hay and fodder, as well as for the operation of shellers, fans, and a feed grinder. All the chop used upon the place is mixed and ground in the mill room in the barn.

FARM MANAGEMENT WORK.

The Horticulturist has been called upon to cooperate with the chairman of the committee on farm management and has assisted in the organization of several farms where truck crops will be an important factor. Cultural directions and crop-record blanks have been prepared for the several truck and market-garden crops to be grown on these farms.

CORRESPONDENCE.

The correspondence of the Office has increased very decidedly over last year. The horticultural publications of the Department, which are many in number, are not sufficient to answer all the questions that arise. This work requires no small amount of time and attention.

TRUCK CROP MAPS.

The distribution and acreage of the various truck crops grown in the United States have been charted on outline maps. These are exceedingly valuable for reference purposes, but, as the areas are con-

stantly changing and the important centers for the growing of certain crops move as a result of industrial and other changes, these maps to be of value to the grower should be corrected annually and distributed after the manner of a crop report for the benefit of planters.

NOTE BLANKS.

Note record blanks for variety testing and crop-record purposes have been prepared with a view to bringing about a uniform system of note taking by the several horticulturists of the United States to the end of making the work in one locality comparable with that in another section. The beginning which was made a year ago encouraged us to renewed effort and we are gratified to report that twenty-one of the State experiment stations are now using these record sheets. The results from this method of unifying this branch of horticultural work will be far-reaching and of great value to the student of plant geography as well as of plant variation. This form for recording notes not only makes it possible intelligently to describe and compare horticultural varieties, but it provides a means by which type descriptions of new sorts may be made and placed on record, by reference to which the variations in that type may from time to time be determined.

PUBLICATIONS.

During the fiscal year the Horticulturist has prepared the matter for four Farmers' Bulletins (Nos. 181, Pruning; 185, Beautifying the Home Grounds; 195, Annual Flowering Plants; and 198, Strawberries). A circular giving suggestions and plans for school gardens was also prepared and distributed.

LABORATORY.

The increased demands upon the office and storage room provided in the barn by the transfer of the seed-testing work to the farm and the storage space demanded by the forage-crop work render it necessary that added room be made available to afford office facilities for the corps of scientists connected with the several lines of work under investigation upon the farm. Suitable laboratories and office rooms are as essential to good results as are successful field operations. The contemplated transfer of the silk laboratory and bee work of the Bureau of Entomology to the farm makes increased quarters imperative. This work will demand a large laboratory room for the silk reels, a specially equipped room for rearing worms, and suitable space for storing cocoons, together with office room for those in charge of the work. The scope of the apicultural work is to be increased, and adequate quarters not only for laboratory investigations but for storing supplies must be provided. Our present buildings are not designed to meet the requirements of such work, and are neither suitable nor adequate for the office use to which a part of the space must at present be devoted.

The fruit and bulb work which has been planned and which is now under way, as well as the silk work, demands cold-storage facilities. No such equipment is now available to the Department except such as can be rented in commercial cold-storage plants. Experience with work under such conditions has convinced us that careful experiments

can not be conducted in commercial concerns. The necessity for such facilities requires no argument, as it is self-evident that for the best interests of the work such facilities must be absolutely under the control of the investigator.

A suitable laboratory building, which will provide space for these several lines of investigation, is rendered necessary. Such a laboratory, properly equipped, would cost $20,000.

GREENHOUSE PROBLEMS.

With the facilities offered at the Arlington Farm for field work with various farm and garden crops, we are enabled to conduct many lines of research which were before impossible; but, as every successful horticulturist realizes, the best results can not be secured unless outside conditions are supplemented by adequate glass structures, and our work with some of the important truck crops is as yet seriously handicapped because of the lack of such facilities. Several of the most remunerative truck crops, in order to give a satisfactory return, require a longer growing season than we normally have in this latitude, and as such plants can be economically handled only under glass, small growers lengthen the season at the beginning rather than at the close by starting the young plants under glass several weeks in advance of the natural planting season in the open. Besides providing for this requirement, glass structures would enable us to take up the cultivation of strictly forcing crops. This branch of work has only been slightly considered at the Department. As a commercial enterprise, in connection with floricultural as well as market work, forced crops are an important factor, involving many millions of capital and the labor of a large army of employees. While we can not hope to settle all the problems growing out of such an industry, yet, in order to conduct investigations intelligently and satisfactorily in any branch of truck farming or floriculture in this latitude, greenhouses become a necessity.

The problems of greenhouse physics, which are the basis for all greenhouse practices both in forcing of flowers and vegetables, are as yet in an undeveloped condition. This, we believe, is one of the most important lines of work which could be undertaken with a view to aiding those engaged in the forcing of plants, because it involves a study of the greatest economic factors entering into the business, viz, the most judicious use of fuel and the most satisfactory mode of obtaining the desired atmospheric conditions in the houses.

The urgent necessity for at least limited facilities along this line impels us to call special attention to this matter. The limited appropriation for the farm has not allowed the erection of such houses for two reasons, (1) the initial cost of the structures, and (2) the means of meeting the running expenses of such a plant, which include not only the maintenance of constant heat during the winter months but attendants and gardeners to insure the success of the work undertaken.

TRUCK-CROP SURVEY.

The trucking interest of the United States, extending from Maine to Florida and Texas, has during the year claimed an increased share of the time and attention of the Horticulturist. In view of the fact that the Southern States are rapidly undergoing radical and far-reaching

industrial changes which are building important local markets by introducing a large consuming population, a new element in the truck work of the region is asserting itself. This factor is the growing of market-garden and truck crops to meet the demands of the rapidly multiplying and rapidly growing factory towns. This, added to the truck business already carried on in these States to meet the requirements of the northern centers of consumption, greatly increases the demand for information concerning truck crops. These conditions increase the importance of taking up a crop survey for this industry.

A majority of the people wishing to engage in this work lack information regarding the soil requirements and cultural treatment for many of the crops it is desirable to grow to meet the demands of one or the other of the above-mentioned markets. This brings to the Horticulturist hundreds of requests for information in regard to these problems. Such questions can not be answered with best satisfaction to the grower unless the individual giving the information has personal knowledge of local conditions. At present such specific knowledge is not possessed by this Office and, until a crop survey can be made, the information which will be most helpful to this industry can not be provided. In our last annual report mention was made of the importance of this line of work. Further observation of the rapidly growing needs of this branch of horticulture convinces us more fully of its importance.

Such a survey would afford information which would enable this Office to give intelligent advice in regard to the possibilities of any region for truck farming, would place it in possession of knowledge with respect to troubles which are likely to arise, and would afford means of actually going into the field and making demonstration tests of cultural and preventive measures when occasion arises. The intensive methods necessary to successful truck farming bring about new conditions which are likely to lead to as serious results in their way as has the single-crop system which has prevailed throughout the Cotton States for the last quarter of a century. To guard against such evil results is better business than to be forced to find a cure for them after they have developed.

This Office is the natural source from which information on truck farming should be forthcoming, and while general knowledge is possessed it is not sufficiently detailed to be as satisfactory as it should be and as growers have a right to demand. To enable the Horticulturist to undertake a truck-crop survey of the United States, either in connection with the Office of Farm Management or independently, $8,000 would be required.

IMPROVEMENTS REQUIRED.

The growth of the work at the Arlington Farm, which is the result of the demand for trial and experimental grounds by various offices of the Bureau and by the development of the horticultural work itself, adds to the cost of maintenance, necessitates the construction of special buildings, calls for the installation of special machinery and implements, and requires additional teams as well as a larger force. While we believe good results have been secured from the expenditures already made, the buildings, though substantial, are less ornamental than one might desire.

TEA CULTURE INVESTIGATIONS.

The details of the work on tea have been looked after during the year in part by the Chief of the Bureau and in part by Dr. Rodney H. True.

The work at Pinehurst, Summerville, S. C., in cooperation with Dr. Charles U. Shepard, has been continued. Since nearly all of the more desirable sorts of tea are now growing at Pinehurst in at least experimental areas, little effort has been made during the past year either to introduce new varieties or to increase with old sorts the area planted to tea. The experiment has been in operation long enough to demonstrate the fact that most of the desirable varieties of the tea plant will grow well at Summerville and probably over large areas of the South. The question of profits is likely to be determined by the factor introduced by the required labor. Since hand work represents one of the largest items of expense, the replacing of this by machinery wherever possible is an end to be sought. Accordingly the chief effort during the year has been directed toward improvement in factory processes. A self-feeding device for the rotary witherer has been perfected by Doctor Shepard, enabling him to dispense with all labor in connection with this machine beyond that of one boy.

One of the most marked improvements resulting from the year's work has been a large apparatus for subjecting the finished product to the process of attrition. A slight friction polishes the tea, and curiously enough increases the aromatic qualities when used. Greater uniformity in the product is also noted as a further advantage. By means of this apparatus tea can be treated in hundred-pound lots with the increase in the desirable qualities noted. The verdict of professional tea tasters has confirmed Doctor Shepard's opinion as to the importance of this process in finishing tea.

The total output of Pinehurst during the last growing season was 8,369 pounds of finished tea, an increase, but a smaller one than would have resulted had the season been even ordinarily favorable.

The Texas tea garden at Mackay, Wharton County, under the immediate charge of Mr. John H. Kinsler, has met with a somewhat varied experience, as would be expected in the early stages of an experiment undertaken under an entirely new set of conditions both of soil and climate. As in other things, so with tea, each separate location offers some peculiarities which must affect to some degree the methods of procedure. The difficulties of the new situation were very much increased by extreme weather conditions: first, continued drought; then, too much rain. As a result some seedlings were lost. At the present time, however, about 15 acres have been planted to tea, which seems to be doing very well. The plants concerned were raised from seed grown at Pinehurst.

The scientific investigations into the processes concerned in tea production have been carried on along two lines. At Washington Mr. W. O. Richtmann, expert in pharmacognosy, has studied the relation of the quantity of tannin and caffeine to the cup qualities of the product. This important relation is rendered very uncertain in large part through the differences in method employed by investigators who have heretofore endeavored to elucidate the matter. Mr. Richtmann has gone further and investigated the general subject of conditions affect-

ing the qualities of the tea infusion, and his results will in all probability be collated for publication during the coming year.

All tea experts are agreed that much of the pleasure found in a cup of tea is derived from the aromatic principles present. Neither the nature of these substances nor the process by which they are developed in the product is definitely known. Dr. Edward Kremers, of Madison, Wis., as expert investigator, has studied some phases of this problem of aroma and fragrance. By means of a large apparatus attached to the factory machinery it was found possible to condense more or less of the products given off during the wilting and firing processes. The investigation of these distillates showed the very gratifying result that only the merest traces of the aromatic constituents were lost in these processes. The study of the tea itself has revealed the presence of traces of substances probably responsible for these qualities, but in extremely minute quantities. These substances seem not to exist in the green leaf but to come into existence as a result of the change of other products during the processes of manufacture. The end sought in this investigation is to get an understanding of these changes, in order, if possible, to assist them, and thereby to increase the aromatic qualities of the product.

PLANS FOR FUTURE WORK.

At Pinehurst the chief aim will be to perfect the factory processes further by means of improved machinery which will either reduce the amount of hand labor and therefore the expense of production or increase the quality or finish of the product.

In Texas the next year's work is likely to consist chiefly in increasing the area of tea in the field, using such varieties as have commended themselves for use in the United States. The scientific investigations now begun should be continued along the lines laid out.

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

CONGRESSIONAL SEED DISTRIBUTION.

During the past year the same general policy prevailed in regard to purchases of seed and contracting for the mechanical work as was mentioned in the report of the Chief of the Bureau for 1903. One important change was made, however, to meet possible criticism where the purchase of large quantities of seed was made by one individual. This consisted in the appointment of a select committee of the Bureau, to whom should be submitted, before orders were placed, all recommendations for the purchase of seed and for entering into contracts for seed to be grown. The offers of seed, with samples, were therefore examined by the Botanist in Charge, and the items it was proposed to purchase, with the reasons therefor, were submitted to this committee.

It may not be out of place here to state the considerations that governed in making up the list of items to be purchased.

First. Preference was given to those dealers known to have good stocks of the variety in question.

Second. In case no definite information in regard to the stocks was at hand preference was given to the firms having the best general reputation for first-class stocks.

Third. If lots of the same variety were offered by dealers of equally good standing, or whose stocks were, in the opinion of our experts, equally good, the order was placed with the firm offering the seeds at the lowest price.

Freight rates were of course considered, because seeds offered f. o. b. New York, for instance, would be cheaper to us than those offered at the same price f. o. b. Chicago.

Seeds of questionable quality were not accepted at any price, and all orders were placed on condition of satisfactory vitality.

The work of packeting vegetable and flower seeds was begun on November 16, 1903, and all work was completed on April 30, 1904. The number of packets of seeds distributed, the quantities purchased, and the number of trees, plants, grapevines, and bulbs distributed are specified below:

Kind of seed and number of packets and packages put up.

Miscellaneous vegetable seed	packets	32,393,324
Miscellaneous flower seed	do	3,665,625
Tobacco seed	do	140,361
Cotton seed	1-peck packages	10,000
Cotton seed	1-bushel packages	11,310
Lawn-grass seed	½-pound packages	20,000
Cowpea seed	2-quart packages	3,200
Miscellaneous seeds	packets	50,000
Total number of packets and packages		36,293,820

At the close of the work, seeds in packets and in bulk and waste seed were left on hand as shown below. The waste seed during the past year was considerably less than ever before, owing to improved methods of recovering seed unavoidably spilled during the work. Such waste seed as can be hand picked is being put into shape during the summer to be used next year, the balance having been sent to the Arlington Farm to be used as fertilizer.

Seed in packets and packages remaining on hand at the close of the distribution.

Vegetable seed	packets	104,967
Flower seed	do	226,555
Tobacco seed	do	77,754
Lawn-grass seed	packages	2,970
Cotton seed	do	1,425

Bulk seed remaining on hand at the close of the distribution.

	Pounds.
Vegetable seed	18,400
Flower seed	1,201
Tobacco seed	62
Cotton seed	1,500
Cowpeas	480
Miscellaneous grains, forage crop, and other seeds (estimated)	30,609
Grains grown at high altitude	5,268
Waste seed	3,000
Total	60,520

The trees, plants, vines, and bulbs distributed were selected by the Botanist in Charge, after consultation with the experts of the Department. The following were distributed:

Trees	56,603
Grapevines	25,040
Strawberry plants	129,350
Bulbs	204,340

SPECIAL DISTRIBUTION OF AMERICAN-GROWN BULBS.

Besides the regular distribution of bulbs, 10,000 American-grown tulip bulbs were distributed for testing. The reports that have so far been received show that for outdoor planting these averaged about the same in quality as the imported bulbs commonly used.

PACKETING, ASSEMBLING, AND MAILING.

The work of packeting, assembling, and mailing was done by the Brown Bag-Filling Machine Company. By a special arrangement the company allowed the Department full purchase price for all empty packets belonging to the Department that were used in the course of the work. The amount due for these packets was $685.68. The amount due the Department by reason of changes in the size of packets was $720.88, and for filled packets used by the contractor, $451.34. The amount due from the Department to the contractor for packets and packages authorized but not used and for extra packeting and sundries was $1,357.27, leaving a balance in favor of the Department of $500.63. This amount was deducted from the face of the last voucher.

EXCHANGE OF VEGETABLE FOR FLOWER SEEDS.

During the fiscal year 1903 it became apparent that much more good could be accomplished in cities by the distribution of flower seeds than by the distribution of vegetable seeds, and plans were therefore made to increase the quotas of flower seeds and decrease those of vegetable seeds when any Senator or Member of Congress desired this done. The plan met with favor, and 334,000 packages of vegetable seeds were exchanged for an equal number of flower seeds.

A circular was also prepared giving directions for the cultivation of plants in window boxes, and a copy was inserted with each package of seeds designed for city distribution. At the request of the Horticulturist, special sets for school gardens were prepared, and 4,000 flower sets and 4,000 vegetable sets were placed at his disposal for this work.

The total appropriation for the fiscal year 1904 was $290,000, which was expended as shown below:

Salaries		$47,987.35
Salaries outside of Washington		10,270.89
Seed and plant introduction, exclusive of salaries		26,547.91
Traveling expenses		3,070.00
Miscellaneous authorizations		8,237.40
Brown Bag-Filling Machine Company		46,236.63
Purchase of seeds and plants:		
Vegetable and flower seed	$85,975.31	
Tobacco seed	1,582.58	
Cotton seed	8,674.51	
Sugar-beet seed	1,468.93	
Lawn-grass seed	921.75	

Purchase of seeds and plants—Continued.		
Miscellaneous seeds	$7,565.49	
Miscellaneous plants	2,951.69	
Trees	461.09	
Bulbs	3,083.84	
Strawberry plants, grapevines, raspberries, blackberries, gooseberries	1,287.48	
Cooperative work on seed-testing experiments	3,906.75	
		$117,879.42
Telegrams		169.67
Freight, express, and hauling		5,197.29
Gas and electric light		123.28
Telephone, rental		26.20
Fuel		1,429.20
Miscellaneous expenses		12,650.75
Total		279,825.99
Amount of appropriation		290,000.00
Balance		10,174.01

Outstanding freight, express, and telegraph bills will probably use up most of this balance.

DISTRIBUTION OF SPECIAL SEEDS.

COTTON SEED.—The varieties of cotton seed distributed at the suggestion of Dr. H. J. Webber, with the quantities of each purchased, were:

	Bushels.
Pride of Georgia	500
Truitt	500
Culpepper	300
Russell	200
Sunflower	700
King	100
Total	2,300

In each package was placed a descriptive circular, together with a return report card. During the past year Doctor Webber has tabulated the reports that were received on the cotton distributed in 1903, and the results are decidedly gratifying. The substance of these reports, together with Doctor Webber's comments, will be published.

The distribution of 150 bushels of King cotton in Texas during 1903 was followed last year by the distribution of 11,310 bushels of early cotton at an expenditure of $9,276.12.

In order to handle this matter so as to place the seed in the hands of the planters early it was necessary to send a special agent to Texas, with headquarters at Houston, to attend to the distribution. The seed was mostly put up in two-bushel sacks, the entire number of sacks distributed being 6,130.

Sea Island cotton.—Two hundred bushels of the Rivers disease-resistant cotton were distributed in Georgia and Florida.

TOBACCO SEED.—The purchase of the regular tobacco seed was effected last year in the same manner as in 1903, except that the Sumatra seed was secured from plants produced from the seed sent to the Department by Mr. Barbour Lathrop. The growing crop was examined by an expert and pronounced a very good type of Sumatra. Part of this crop was grown in Florida and part in Connecticut, the

seed from Florida being used for the southern distribution, while that from Connecticut went to the North. Five hundred and thirty-one pounds of tobacco seed were purchased at a cost of $1,582.58.

Iron cowpea.—Two hundred and twelve bushels of the Iron cowpea were distributed. Besides its value as a disease-resistant variety, the "Iron" is also the heaviest cropper in the extreme South, and the seeds do not have the strong and disagreeable flavor characteristic of other cowpeas.

Sugar-beet seed.—Twelve thousand pounds of sugar-beet seed were purchased from one American grower and 3,000 pounds from another, besides a few other small lots of domestic and foreign production. The seed was almost entirely distributed in lots of 100 pounds to parties who agreed to make a comparison between the crop resulting from this seed and from that furnished by the factory.

Only a few reports were received from those to whom seed was sent in 1903, but these state that the American-grown seed is equal to the commercial imported and indicate that with care in selection of roots a superior grade of seed may be produced.

Lawn-grass seed.—Two kinds of lawn-grass seed were distributed during the past year. To the Gulf States and to the States and Territories in the Southwest was sent seed of Bermuda grass, which is undoubtedly the best lawn grass for hot and dry situations. To the other States a mixture of redtop, Kentucky bluegrass, and white clover was sent. The total number of packages distributed was 20,000.

Forage-crop seeds.—During the past year a systematic plan for the distribution of forage-crop seeds was developed and put into experimental operation. In accordance with this plan, correspondence was entered into with many applicants for grass, grain, or clover seed, and an effort was made to reach an intelligent understanding in regard to the conditions under which the plants would have to grow and also as to what kinds of crops would prove most valuable to the correspondents. Seed was then sent in sufficient quantity to plant at least a half acre, and detailed directions and suggestions in regard to culture accompanied the seed. The advice of the Agrostologist was freely asked and his assistance was readily given to select the best possible seed to send. In this way more than 700 correspondents were supplied with from one to ten kinds of seed in quantities sufficient to plant from one-half acre to 5 acres.

SEED GROWING.

Sugar-beet seed growing.—The work on the production of sugar-beet seed was continued at the New York Agricultural Experiment Station, Geneva; at the Michigan Station, Lansing; and with Mr. E. H. Morrison at Fairfield, Wash.

At each place a small quantity of seed was harvested in the autumn of 1903 from carefully selected beets testing 18 to 21 per cent sugar, and this pedigree seed was planted in the spring of 1904.

Besides the production of this seed, a test was also made of several strains of domestic and imported seed. The conclusions to be drawn from the results obtained were that while the seed at present produced in the United States is equal to that generally imported, it is possible to produce much better seed by proper methods; also that a test for

one year is merely indicative of results that may be looked for, and by no means conclusive. This was shown by the lack of regularity in the results obtained from seed of the same lot planted in different sections of the United States.

CAULIFLOWER SEED.—The efforts made to grow cauliflower seed on Long Island were at least partially successful last year, a few ounces of seed being produced. It is thought that this is a long step in advance, since the seed produced will be somewhat acclimated and more likely to yield seed-producing plants.

GROWING SPECIAL COTTON SEED.—During the past year this Office assumed the expense of growing several acres of two new varieties of wilt-resistant Upland cotton. On account of the unfavorable season the quantity of seed received was not as large as had been hoped for, and this was reserved for stock seed to be planted the present season.

Our work along these lines supplements that of the experts of the Bureau, the fields being in charge of these experts. When enough seed has been raised it will be distributed through Congressional channels. The general distribution of a strain of wilt-resistant cotton alone will be of great value to the South, since a conservative estimate places the annual loss from wilt at half a million dollars.

Seed of two new varieties of selected Egyptian cotton was also grown under contract, the fields being in charge of Doctor Webber. This seed was also reserved for stock seed.

TRIAL GROUND WORK.—The trials of vegetable seeds made last year excited much interest among professional growers and seedsmen. They demonstrated the fact that many, even of our standard varieties, are sold under different names and that different varieties are sold under the same name; while, even when the type of the variety is well understood, as in Crosby's Early and Stowell's Evergreen sweet corn, seed grown in different parts of the country varied widely, not so much because of the difference in soil or climate as on account of the different ideals toward which growers were selecting.

There is much greater need for the uniformity of existing types than for the production of new varieties, at least in vegetables. Tests were made of 1,405 samples in all, including beans, peas, sweet corn, cabbage, and cucumbers. At the conclusion of the present season's work it is hoped some of the descriptions prepared may be published. On the trial grounds on the Potomac Flats 1,500 samples of vegetable seeds were planted, including 224 samples from the Congressional distribution. These tests showed that the quality of the seed used in the free seed distribution was fully as good as that furnished by the better class of seedsmen.

BULB GROWING.—In order to prosecute our work in growing bulbs in the United States with a better knowledge of actual conditions Mr. George W. Oliver was sent to the Pacific Coast with instructions to visit all the bulb growers and to find out what was being done and what the Department ought to do in order to give an impetus to this industry. Mr. Oliver covered the ground from Washington to southern California and found that already the growing of the narcissus is perfectly successful and that there is every reason to believe that tulips, hyacinths, lilies, and many other bulbs can be readily grown. Later, Mr. Oliver was sent to North Carolina to study conditions there, and

found that besides the tuberose and cannas, which have become standard crops in that section, there seemed good reason to believe that certain other bulbs might be grown to advantage.

PLANS FOR FUTURE WORK.

During the ensuing fiscal year the number of packets of vegetable seeds that will, according to the present plans, be distributed is 32,190,000, and of flower seeds, 3,622,500.

The distribution of trees will be omitted and the bulbs distributed will be gladiolus and tuberose, instead of Dutch bulbs. Strawberry plants and grapevines will be distributed as usual. An expert will be secured, who will devote himself to the distribution of forage-crop seeds and grains on special request. This will doubtless develop into an important branch of the work. Seeds of varieties introduced from abroad or discovered in this country and found to be good for certain parts of the United States will be distributed in larger quantities through this branch of the work, and thus the results obtained by the Department experts in discovering or producing new varieties will be brought close to the people. As in the past, much of this special work will be carried on through the cooperation of the other offices in this Bureau.

This year a new wilt-resistant variety of the Sea Island cotton, thought to be better adapted to the conditions prevailing in Georgia and Florida, is being propagated under the direction of one of the pathologists.

Plantings have also been made of three varieties of Egyptian cotton, one of which is a hybrid. These fields are in charge of Doctor Webber and will yield seed that will be used either for immediate distribution or for stock seed, as circumstances may warrant.

Tobacco.—The tobacco seed secured by Mr. A. D. Shamel from Cuba is being used in connection with his work in selecting a desirable type of tobacco. Plans are now under way by which the production of high-grade tobacco seed may be possible under the auspices of the Department. Such a distribution would be of the greatest benefit to the tobacco industry, and should certainly be extended to all the leading tobacco regions as rapidly as the funds available will permit. By thus cooperating with the Plant-Breeding Laboratory this Office could gradually place a superior grade of seed in the hands of the growers of tobacco.

Corn.—The testing of varieties of field corn by Mr. C. P. Hartley, with the assistance of this Office, will continue during the coming year.

Sugar-beet seed.—Work on the production of sugar-beet seed is being done this year at Geneva, N. Y.; Lansing and Holland, Mich.; Logan, Utah; and Fairfield, Wash. At Holland and Logan the work has just been begun, while at the other places it is a continuation of last year's work. We shall this year secure beets raised from seed of our own breeding. The tests of these beets will show whether or not the work is advancing. The roots selected last autumn and individually analyzed this spring were carefully recorded and planted, and they promise to produce a good crop of seed this summer. No roots testing less than 18 per cent of sugar were saved for this work, while

the best root showed 24.2 per cent. At Fairfield, Wash., where a scientific aid is stationed to look after the several branches of the work, some 2,000 roots were analyzed with the result that we now have growing 200 roots testing from 18 to 23 per cent, 57 of them showing 21 to 23 per cent of sugar. Comparative variety tests are also being made at Logan, Utah, the work being done under conditions where the water supply can be controlled. This is considered important in growing beet seed under irrigation.

Testing grounds.—During the current year 2,653 vegetable tests are being carried on under the direction of Mr. W. W. Tracy, sr., at the following places: Arlington Farm; Storrs, Conn., with the Connecticut experiment station; Lincoln Nebr., with the Nebraska experiment station; Brookings, S. Dak., with the South Dakota experiment station; Columbus, Mo., with the Missouri experiment station; Orono, Me., with the Maine experiment station; Leroy, N. Y., with N. B. Keeney & Sons; Floral Park, N. Y., with C. L. Allen; Mattituck, N. Y., with J. M. Lupton; Greenwich, N. Y., with E. L. Coy. These tests are of beans, peas, sweet corn, cabbage, and cucumbers. The work is all being done well, especially at the experiment stations, and descriptions of the standard varieties of some of these groups will be published during the winter.

Corn for canning.—There is much interest in corn-canning circles in regard to the regions from which the best canning corn may be secured, and there is much need of definite information on this subject. Plans were made, therefore, to solve the question, and seed of the standard canning varieties—Stowell's Evergreen and Crosby's Early—grown in different States was secured. Although these varieties are old and standard sorts, and the seed obtained was specially selected by growers of the best reputation, it was found that this seed differed so materially in character that any difference in the product could not with certainty be ascribed to the effect of the localities where it was grown, but might come from the difference in ideals followed in selection. Accordingly stock from one of the best growers was procured and arrangements made to have this planted in Connecticut, Minnesota, Nebraska, Missouri, and at Washington, D. C. Next year, seed carefully selected by the same expert from these fields will be planted where canning corn is grown and the product canned, thus eliminating, as far as possible, all differences except those resulting from location and soil. The proposed work has excited much interest among canners, and we hope for results of great practical value.

Date gardens.—The fact that the later and better varieties of dates did not mature at Tempe, Ariz., made it desirable to locate a garden in the Colorado Desert, where the conditions appear ideal for successful date culture. The Mecca Land Company offered land and water and deeded 15 acres to the director of the California experiment station to be held in trust by him for this purpose.

The land selected lies on the Southern Pacific Railway, and is a sandy loam with a good artesian well flowing a sufficient stream to furnish the water needed for 15 acres of dates.

The palms in the garden at Tempe, Ariz., continue to show satisfactory progress, many young suckers being developed, some of which should be large enough to distribute next year. During the past year about two dozen boxes of fruit were harvested from the Rhars variety.

These were of good quality, and a few boxes were distributed as samples. Others are now on exhibition at the Louisiana Purchase Exposition, St. Louis.

Date introductions.—During the past year two importations of date-palm suckers have been made from Algeria, one from the Algerian Sahara region and one from the oasis of M'Zab. These made a total of 267 suckers of 60 varieties, 47 of which were not before introduced. Of these, 207 suckers were sent to the Mecca garden, while 54 were added to the collection already established at Tempe.

Turkestan alfalfa.—The Turkestan alfalfa seed that was imported in 1903 and mentioned in the report of the Chief of the Bureau of Plant Industry for that year was distributed largely through the cooperation of members of Congress, 20 pounds of seed being offered to each of 156 persons. Of these, 86 accepted the terms proposed and received the seed, but of these only 49 signed the contracts when sent to them, the others failing to do so for various reasons. Since the first distribution 15 contracts have been made with other parties, some for larger acreage than at first proposed. Of the total of 64 contracts thus entered into, 57 have been renewed for the fiscal year 1905.

The reports received from those who received the seed point clearly to the hardiness of this variety, but they also indicate that final conclusions can not be drawn from one season's work. Some of the correspondents in the extreme Northern States report that in spite of the extremely severe winter of 1903–4 the Turkestan alfalfa suffered but little.

Alkali-resistant alfalfa.—The tests of the Algerian and Turkestan alkali-resistant varieties of alfalfa in California and Arizona indicate that these sorts will probably thrive on soil containing 1 per cent of alkali. It is very difficult to induce farmers in the desert regions to undertake experimental work, and hence the careful tests needed for these seeds can not always be carried out. This makes results slower, but there is every reason to believe that this alfalfa can be grown on soil much more alkaline than that on which the common variety will thrive.

Arabian alfalfa.—Two lots of alfalfa grown from seed secured in Arabia have been under test at the Pomona substation of the California experiment station. It is giving such extraordinary promise of value that arrangements have been made to secure all the seed possible of this variety.

Berseem.—Under a contract with the director of the Arizona experiment station a systematic effort was made to test berseem on the overflowed lands of the Colorado, near Yuma. Thousands of acres of rich bottom land are there lying idle simply because they are subject to annual overflow, which destroys alfalfa and makes orchard crops out of the question. It is thought that berseem should prove a valuable forage crop here, since good hay always commands a ready market at a good price. Systematic tests were also started in various States of the South where the place of berseem must be determined. In Colorado, tests were started with it as an orchard cover crop. This work will run over into the ensuing year. Some 5,000 pounds of seed were imported during the past year.

Mangoes.—During the past year 34 varieties of mangoes were imported, making in all 54 varieties at present in the propagating

houses. Of these, a sufficient number of plants was secured to enable us to send 23 varieties to Florida for a fruiting test. The most important matter connected with mango culture is to secure tests of the imported varieties, so that we may know what sorts should be most largely propagated for distribution. A collection of varieties has been established at the Subtropical Gardens at Miami, and this will be added to in the future.

Fruiting tests are being made at various points in Florida to enable us as soon as possible to get the range of each valuable variety. The plants of the Gordon mango imported by this Office have fruited and the fruits are large, of pleasing shape, and of excellent flavor.

Flax.—Professor Bolley brought back 268 lots of flax seed on his return from Russia. These were collected from all parts of Russia and from every important center of flax culture. He did not find a variety immune to the flax wilt, but some strains showed signs of affording valuable material for selection. Among the lots of seed secured were some very valuable fiber flaxes from noted estates, where the seed has been selected for many years.

Mexican peach seed for stocks.—The Mexican peach seed secured by Mr. G. Onderdonk was distributed to reliable nurserymen and experiment-station workers, and reports have been received in regard to the hardiness of the plants the past winter. These show that in the North and East these seedlings are not hardy, while in the South, and especially in Texas, they give promise of unusual vigor.

Of the Mexican apricots and peaches secured by Mr. Onderdonk and propagated for us by Mr. George Taber, 514 trees were distributed for test during the past spring.

Grape work in California.—The work in testing the resistance of stocks to phylloxera, the adaptability of different varieties to the varying soils of California, and the congeniality of the valuable European grapes to these hardy stocks was continued during the past year in cooperation with the Pomologist of the Bureau. To the two established last year has been added a third vineyard, as well as six small plantings of 1 acre each. Seventy-five varieties of resistant French grapes were imported last year and sent to our gardens in California. The work is of such a character that no special report, save of progress, can be made for a few years.

CEREAL WORK.

The work on cereals has, as usual, been one of the most important lines in this Office. It is in charge of the Cerealist of the Bureau, and the following statement has practically been prepared by him. The work has been carried on principally along the following lines:

(1) Experiments with winter wheat.
(2) Trials of Russian proso (broom-corn millet).
(3) Experiments with winter varieties of oats and barley for the South.
(4) Further trials with introduced varieties of oats.
(5) Some experimental trials with introduced rye.

Experiments with winter wheat.—A number of further trials have been made during the year by experiment stations and private growers to determine the possible northward extension of the winter-

wheat area. These trials resulted in the confirmation of previous conclusions that the winter wheat can be grown practically all over Iowa and Nebraska and a considerable portion of South Dakota and southern Minnesota. Winter wheat of the Crimean type, particularly of the variety Kharkof, even survived the winter in good condition at Lisbon, N. Dak.

It is important to note that in all cases of trials made so far the winter-wheat varieties yield considerably more to the acre on the same land than the spring wheat commonly sown in the same locality.

Russian proso.—For several years a number of varieties of Russian proso have been under trial in this country. The three best of these varieties, Red Orenburg, Red Voronezh, and Black Voronezh, have been mentioned in a previous annual report and have been given more attention than other kinds.

The results of trials of these grains in North Dakota, South Dakota, and in other portions of semiarid regions have been excellent. During this year more experiments have been made with proso than at any time before, and in the spring of 1904 a very thorough distribution of the three varieties mentioned was made, the results of which, however, can not be given in this report. Reports of experiments received up to date show that one can expect from 20 to 30 bushels of seed per acre under average conditions in semiarid districts and that proso furnishes fairly good hay. Such results are far better than having to depend upon the constantly deteriorating ranges in the West for food for cattle and other stock. A large quantity of proso is now being grown in the Northwest. It has been found to be a good food for sheep, 300 acres having been grown on one farm for this purpose last season. Recent experiments at the South Dakota Experiment Station show that the grain can be depended upon for the profitable production of pork, the quality in some respects at least being better than that of pork produced with barley or wheat, although the amount of gain in weight is not so great.

Trials of winter oats and barleys.—Much time has been given to experiments with winter oats and barleys, as it is of the greatest importance to establish thoroughly reliable winter varieties in the Southern States. Certain varieties native to this country have been developed to the extent of being fairly hardy, such as the Culberson Winter oat and the Tennessee Winter barley, although the former is still rather unsatisfactory for an average of many seasons. An effort has been made to secure foreign varieties still better than these, if possible; and while the experiments have not as yet been sufficient to allow definite conclusions, principally because of the inadequate quantity of seed obtained so far, there are indications that several of these introduced varieties will prove to be particularly hardy.

It is of further interest, too, that one of these introductions, the Hankau barley, is also a hull-less variety. To establish thoroughly a winter variety of hull-less barley will be a matter of the greatest importance. A black barley from Arabia, and two or three other barleys and oats, appear also to be sufficiently hardy for fall seeding.

Further trials with introduced varieties of oats.—Results of trials with the Swedish Select oat appear to be more favorable each year. This variety is now considered generally in Wisconsin and Montana to be the best of all kinds grown in those States. Its yield

is not only much larger, but the size and weight of the grain are considerably greater than those of any other variety in the Northwest. Its cultivation is not yet so extensive in North Dakota as in the States mentioned, but the indications are that it will become equally popular there. The weight per bushel in Wisconsin is commonly 40 pounds, while not rarely it reaches 50 pounds in Montana. About a quarter of a million bushels were produced in Wisconsin in the season of 1903, and in the entire Northwest several million bushels will no doubt be harvested during the season of 1904.

The Tobolsk oat is also a very hardy and thrifty variety, and has given good results in North Dakota, but the trials of this variety have not been nearly so extensive as those of the Swedish Select. The quality of the grain is not nearly so good as that of the Swedish Select, but the plant is very hardy. The Sixty-Day oat has proved to be an excellent variety in Kansas, Nebraska, and other localities that appear to be too far south for the best results with the Swedish Select oat. The most important quality of this oat is earliness, and the present season the great value of this quality is being shown in a pronounced manner in certain localities where there has been a great amount of rainfall and severe attacks of rust. This variety, because of ripening so much earlier than others, has been able to escape the rust, while other varieties, in some cases, have been practically destroyed by rust or on account of lodging, as a result of so much rainfall.

New varieties of rye.—Two varieties of rye, the Ivanov and the Abruzzes, first introduced without any particularly strong evidence of their value, have finally proved to be excellent grains in some respects. The Ivanov, from Russia, is a very hardy rye, usually growing a little taller than other varieties by the side of it, and is well adapted for almost any kind of soil, including rather poor soils. Its hardiness would indicate that it may do well in districts very far north as a fall-sown rye. The Abruzzes rye is, on the other hand, apparently well adapted for use as a spring rye, and is particularly good for pasturage and hay. Nevertheless, in certain instances it has also produced very good grain. In southern Kansas this variety is thought to be the best yet introduced simply as a forage rye. Reports from Kansas also indicate that by a little selection it may develop into an excellent winter rye in that section. A reliable correspondent, referring to it as a winter rye, writes:

> It grows upright in the fall, instead of creeping as other ryes. This makes one acre of it worth 3 or 4 acres of other rye for pasture. It has wide, rank blades, and being a nearly upright-growing rye, it will become a foot or more high in the fall.

Other work with cereals.—Besides the experiments above mentioned, work has been continued with a number of other grains, including the durum (macaroni) wheats. The durum wheat needs no further experiments from the standpoint of cultivation through the Northwest, but a large portion of the work of the year has been an investigation of the commercial value of this wheat in cooperation with various bakers, experiment stations, and the Bureau of Chemistry of this Department. Through a large series of experiments on the use of the wheat for bread it has been determined that it is excellent for producing bread as well as for the manufacture of macaroni. Certain varieties of the wheat have also been under experiment in other parts of the country, giving good results, particularly in Arizona and south-

ern California, where the variety Marouani gives especially good results.

The two Algerian varieties of barley, Beldi and Telli, have been giving excellent results at a number of points in the Southwest, particularly in Texas, the yields in some instances being three times as great as that of ordinary barley growing on the same farm. The Hanna barley has also continued to give excellent results throughout the Northwest as a cultivated grain, and has, besides, done well in Texas. Two thousand pounds of the original Hanna barley were imported during the past year and distributed among those who grow barley for brewing purposes.

CASSAVA.

The collection of cassava plants secured last year has been planted in the Subtropical Gardens. Seed was distributed to several persons interested, but by reason of an early frost they all lost their stock. Plantings were also made with a view to having the roots milled for starch and additional stock of each variety was propagated.

MINOR INTRODUCTIONS.

Among the minor introductions of the year are some Vladimir cherry trees from Russia; pistache seeds from Europe, Asia, and Africa, from which to grow stocks on which the better varieties of pistaches may be grafted; a few pounds of Brazilian tobacco seed, secured after much effort; a collection of seeds from Abyssinia, secured through the assistance of Consul-General Skinner; a consignment of Japanese matting rush plants, and several hundred pounds of *Phaseolus viridissimus* seed, which promises well in the arid South and West. About 1,000 pounds of red clover seed were also imported from Russia to continue the work begun some time ago on the relative value of American and European clover seed. This work is being done in cooperation with the Seed Laboratory. In all, about 1,600 numbers were added to the list of our importations.

DEMONSTRATION FARMS.

During the past year demonstration farms have been conducted at San Antonio and North Galveston, Tex., and at De Quincy, La. At San Antonio fall crops were planted in the autumn of 1903, including barley, oats, crimson clover, hairy vetch, and a large number of small samples. Unfortunately, the extraordinary drought of that season prevented the success of any of these experiments, the crops being entirely destroyed. Spring crops of corn, cotton, sorghum, etc., were put in last spring.

The principal problems at San Antonio were securing plants that would thrive in dry seasons and so conserving the water supply that the normal rainfall would suffice for the needs of the crops.

A contract was entered into between the mayor of San Antonio and the Department by which the Department has entire control of about 125 acres of land near San Antonio, to be used as an experimental farm. Horses and tools have been bought by the Department and buildings have been constructed by subscriptions from the business men of San Antonio.

At North Galveston a number of varieties of rice were tested in a preliminary way, but being the first year that this farm was operated there was a lack of water and other necessaries, making the work simply preliminary. A well was, however, put down and everything arranged for successful work during the present season. The company owning the land was asked to furnish suitable buildings, and arrangements are being pushed toward a final contract by which the Department will obtain control of the land.

Contracts have been made with the Edgewood Land and Logging Company by which that company furnishes 160 acres of land and certain buildings for a period of ten years and the Department agrees to operate a demonstration farm during that time. During last fall a few acres were broken up without removing the stumps, and crops of Irish potatoes, cowpeas, sorghum, and a number of cereals and grasses were planted. The sorghum and cowpeas appeared to succeed best.

The problems to be worked out on land of this character are improvement of the fertility of the soil, successful drainage at a low cost, and the introduction of plants that will live where a hardpan underlies the surface and makes a shallow soil, wet at some seasons and dry in others.

FUTURE WORK.

Plant introduction gardens.—During the current year the plant introduction gardens will be more firmly established and collections of economic species secured to furnish material for selection, hybridizing, and introduction.

Foreign explorations.—An expedition will be sent to Africa and southern Europe to secure further fine varieties of date palms, olives, and pistaches. Such dates as the Menakhir, which are of exceptional size and quality, must be secured as soon as possible, since propagation is a slow matter. Arrangements will also be completed for securing date palms from Arabia, through the assistance of an American missionary, and from Nubia, through a commercial agency in Egypt. The varieties secured will add very materially to the collections at Tempe, Ariz., and Mecca, Cal.

Hops.—The work on European varieties of hops, temporarily suspended, will be taken up during the year and the best sorts will be brought together for introduction, or for hybridizing if that seems the best way to improve the quality of American hops.

Demonstration farms.—The work being done this year on the San Antonio farm is the growing of crops of corn, cotton, sorghum, etc. At present everything looks very well and there is a prospect of securing a successful crop.

At North Galveston a crop of rice is growing, consisting of a number of varieties, which are being tested and propagated, and at De Quincy, La., crops of sorghum and cowpeas are growing to provide feed for some stock and to improve the soil.

Turkestan muskmelons.—A thorough test of the imported varieties of muskmelons, some of which were introduced several years ago, is being made in cooperation with the Utah experiment station. Some of these are valuable for table use in the winter and others for stock feed. The best varieties will be selected for propagation.

JAPANESE MATTING RUSH.—The work of demonstrating the culture of *Juncus effusus*, the rush from which Japanese matting is made, will be continued. A good strain of this plant grows wild in California, and propagating stock can be secured there for planting in Texas and South Carolina.

CEREAL WORK.—The work of testing the introduced grains is being pushed, especially at five points, viz, North Dakota, South Dakota, Washington, and two places in Texas. The varieties adapted to the conditions prevailing in these places are being tested and propagated.

JAPANESE BAMBOOS.—A systematic attempt will be made to introduce and establish the valuable timber bamboos from Japan. A number of plants will be imported and established at various points in the South, to remain under the control and observation of the Department experts for a term of years.

BREWING BARLEYS.—Arrangements have been made to make tests on a large scale of the best barleys for brewing purposes and to import the best European varieties. The cooperation of the best brewers has been secured and the work is reasonably certain to solve some important problems.

BROAD BEAN.—Of the broad, or Windsor, bean there are many varieties, some of which are highly regarded abroad as a table vegetable, while other sorts are chiefly valuable as fodder. Importations have been made of the seed of the best varieties for all purposes. A special use for this bean appears to be as a green manure crop in California. This Office, working in cooperation with the California experiment station, has already shown that fenugreek is a valuable crop for this purpose, but that for many reasons *Vicia faba* would be better still. Seed of a small-seed variety was therefore imported and experiments are now under way to determine its value for such purposes.

CASSAVA.—Milling tests will be made this year of the cassava roots planted for this purpose, and arrangements have been perfected to have chemical analyses made of roots of all varieties.

MINOR INTRODUCTIONS.—Arrangements are also under way to introduce, experimentally, several minor crops, like the chayote, as vegetables for the South; the Japanese paper plant; long-kerneled rices from Italy and other points for South Carolina; European and Asiatic varieties of fruits, and some rare ornamental plants.

REPORT OF THE FORESTER.

U. S. Department of Agriculture,
Bureau of Forestry,
Washington, D. C., September 28, 1904.

Sir: I have the honor to transmit herewith a report of the work of the Bureau of Forestry for the fiscal year ended June 30, 1904, together with an outline of the plans for the work of the Bureau for the current fiscal year.

Respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson, *Secretary.*

INTRODUCTION.

During the past year the Bureau of Forestry has made notable progress in the efficiency, compactness, and simplicity of its organization, in the quality and amount of its work, and in the actual number and relative proportion of trained men in its personnel. It has been more successful than ever before in spreading both a knowledge of practical forestry and the desire to practice it among owners of timberland, and in collecting and digesting information about American forests on which to base the rules for conservative lumbering in different localities so as to make it pay. To the majority of forest owners forestry is necessarily a question of business, and the fact that the more progressive lumbermen have come to realize this truth and to act upon it is full of promise for the perpetuation of the forests and hence of the lumber supply. The number and efficiency of foresters trained in American schools is greater than ever before, and forestry as a profession is taking its legitimate place. Among the general public there is greater interest in forestry than at any former time, and it is steadily growing.

All this is encouraging, but the situation has another side. The available means to check forest destruction are increasing, but so are the forces which make for the obliteration of our forest wealth. Railroads are pushing steadily into new regions, bringing with them not only destructive lumbering but also fire, which is far more dangerous. The rise in the price of lumber and the dwindling supply of logs of the better grades both combine with the greater accessibility given by the new lines and lower rates of the railroads to make it profitable for the lumberman to extend his operations into regions farther and farther from his mill and his market. In addition, the rapid progress of settlement is constantly bringing the local market and the forest nearer

together, and the general consumption of lumber is growing steadily with the increasing population and prosperity of the United States.

It is evident that never before has forest destruction been so rapid as at present, that we have never been so near to the exhaustion of our lumber supply, and that vigorous measures have never been so urgently required as now. Judged in the light of its beginnings and opportunities, the progress of the Bureau of Forestry is perhaps not unsatisfactory. Judged in the light of the task which must be accomplished, if the United States is to escape the hardships of a prolonged lumber famine, its work has scarcely begun.

The problem of internal organization of the Bureau presented by the accumulation of data collected in the field was met by a thorough overhauling of the material now on hand and by new methods for bringing facts together and making them available in the most practical way. These facts, furnished by field parties working in every part of the country, consist of field notes, reports, surveys, and hundreds of thousands of counts and measurements, besides personal first-hand acquaintance with forest conditions in every part of the United States. How large a task the collection and working up of these facts was during the past year the statement of the work done by the section of Forest Measurements partly shows. The Bureau is now better equipped than ever before to handle and apply to practical forest problems the scientific knowledge which it has, to direct its future studies along fruitful lines, and to bring the results of its researches into published form.

A new classification of technical grades now applied in the Bureau is as follows:

Forester; associate forester (chief of the ranking office and assistant to the Forester); assistant forester (chiefs of offices and men occupying positions of similar responsibility); forest inspector (chiefs of the ranking sections of offices and men in charge of independent lines of work of similar importance); assistant forest inspector (chiefs of sections of offices, except of the ranking section, and men occupying positions of similar responsibility); forest assistant (men who enter the Bureau through the examination for forest assistant and have not yet been given charge of independent lines of work); forest agent (men without civil-service standing in charge of subordinate lines of work); forest student (men whose service is temporary and educational in character and whose training in forestry is incomplete).

Besides the work immediately centered, under the present scheme of organization, in the Office of the Forester, and which includes Reserve Boundaries, Cooperative State Forest Studies, Forest Law, and Editorial Work, the organization of the Bureau includes the subjects of Forest Measurements, Forest Management, Dendrology, Forest Extension, Forest Products, and Records.

RESERVE BOUNDARIES.

During the field season of 1903 examinations for new forest reserves were made in nine States and Territories of the West. Twenty-two men were engaged in this work. In addition, an extensive examination was made in Alaska. The general public recognition of the high character of the work has been and is most gratifying.

The purpose of the reserve boundary work of the Bureau is two-

fold. It is carried on, first, to prevent the destruction of forest growth on public lands hitherto unreserved where these lands will be permanently most useful to the communities interested in them if kept under forest, and, secondly, to bring about the elimination from reserves of land worth more for agriculture, mining, or other purposes. The public domain has been passing so rapidly into private ownership that it was at first necessary in many cases to act hastily in making forest reserves if anything worth reserving was to be secured. These reserves will be the remnant of the vast empire that lay beyond the Mississippi which can still be handed down as a national heritage after all the rest of the public lands worth having have become private property. But it is the avowed purpose of the Government to withdraw no land from settlement for forest reserves which can be put to better use in other ways, and examinations are therefore made by the Bureau to secure the correction of boundaries which include too much as well as to discover where additional areas should be included.

One hundred and thirty-four maps in duplicate, or 268 maps in all, and 67 reports have been prepared in connection with reserve boundaries during the year. The total expenditure under this head was $60,282.91, including salaries, or 17 per cent of the total appropriation of the Bureau.

COOPERATIVE STATE FOREST STUDIES.

California.

The study of the forests of California begun last year in cooperation with the State was continued, occupying 28 men for four months. The field work comprised the mapping and description of the forest on approximately 20,500,000 acres. The types of land mapped were: Timberland, woodland, brush, pasture, farm, burned (restocking and not restocking), and cut-over land (restocking and not restocking). The descriptions of the forest include an account of its composition and condition and a rough estimate of standing timber, with particular attention to the effects of fire, grazing, and lumbering.

In making a study of the growth and value of planted eucalypts practically all the important groves in California were visited, and their rate of growth was determined. The results will show for the blue, red, manna, and sugar gums what growth and returns may be expected under various conditions in southern California.

A study was made in the San Gabriel and San Bernardino forest reserves to determine the possibility of improving the cover of chaparral on important watersheds. A reconnoissance was made of the entire area of the two reserves, but special attention was given to the Los Angeles, San Gabriel, and San Bernardino watersheds, which embrace the more important chaparral areas. The specific questions considered were the conditions under which forest replaces chaparral, the character and composition of chaparral on various slopes and elevations, the value of chaparral as compared with forest in water conservation, and methods of improving the chaparral cover of the watersheds by protection and planting.

The study is complete for the region named, and leads to several important conclusions, among which are the facts that there is very little tendency on the part of the forest to replace chaparral, but that chaparral replaces forest almost constantly as a result of fire; that the

two important methods of improving chaparral are protection from fire and planting; and that there is great need for both. Protection from fire must be assured first, since the success of planting depends upon it. Large areas in the interior of the mountains are especially in need of planting; because they lie at the head of important drainage basins and owing to recent fires are very nearly barren, although they formerly bore excellent timber. Isolated areas can also be found on the exposed south front of the mountains, where planting is urgent and can be successfully accomplished. The study will be continued in other portions of California.

A study of the replacement of the natural forest on denuded areas was in progress throughout the year in the Santa Barbara, San Gabriel, San Bernardino, and San Jacinto forest reserves. The most detailed work was done in the San Bernardino Reserve, where a field party worked during the winter months. Though the conditions present are in many ways similar, the mountains show extreme variations in forest reproduction. The main questions studied were the extent of forest in the past, the sufficiency of reproduction at present as compared with the necessary future forest area, the effect of fire upon forest reproduction, the contest between forest and chaparral on burned areas, and the rate of growth of young forest trees.

Taken with the chaparral study the results go far to establish the extent to which the mountain slopes on important watersheds are being covered by young timber. They also show the character of reproduction in localities which, like parts of the San Bernardino Mountains, have been fully protected from fire, and on which young growth is thrifty and abundant. A third practical result of this work is to show upon what important watersheds the forest cover is extremely poor, and where efficient protection and extensive planting are peculiarly needed in order to restore the mountains to a safe condition as watersheds.

The study of forest fires in California has been continued and is now nearly complete. Its results will be used in recommendations for the organization of a fire service which will reduce to the minimum the State's losses by fire.

Maryland.

A descriptive study (conducted in connection with the work under Dendrology) was made, in cooperation with the Maryland geological survey, of the forests of Worcester County. Based upon this a detailed forest type map and report have been prepared for publication in the annual report of the State geologist. The study is important, particularly as bringing out the commercial value of large areas of loblolly pine, which, owing to the presence of good local markets, may be profitably worked for fruit boxboards under a forty-year rotation. The report further deals with a classification of the woodland types, their extent, location, and composition, and with the available stand, consumption, and uses of timber. Recommendations for profitable management are also included.

Massachusetts.

At the beginning of the fiscal year the Bureau began, in cooperation with the Massachusetts Forestry Association, a study of forest conditions in Massachusetts. This study, while dealing with specific

problems of importance in the State, was organized on the part of the association as a preliminary step toward the formulation of a State forest policy.

An important part of the cooperative study has been a close examination of the damage done the forest by fire and the effectiveness of present laws to secure fire prevention. The study of this subject occupied three months of field work in 1903. A comprehensive report has been submitted, which describes the damage from fire and the efficiency of present means of fire control, and proposes an entirely new fire law.

A second part of the work is a study, the report upon which is now almost complete, of the forest planting which has been done on the watershed of the Wachusett Reservoir, near Clinton. This watershed gathers a large part of the water used by Boston, and was originally in large part open farm land. Within three years nearly 700 acres of open land nearest the reservoir have been planted to a mixture of white pine and sugar maple under a planting plan made by the Bureau. The forthcoming report is descriptive of the methods used in planting, the cost, and the results. The report gives a valuable exposition of practical forest planting in New England.

The results gained from the cooperative work have been used effectively in the Massachusetts State legislature in securing the passage of a law providing for a State forester. In consequence of the enactment of this law a forest system will now be established, and the Bureau's cooperation with the State forestry association will be closed with the end of the fiscal year.

New Hampshire.

The field work necessary to a study of the forests of northern New Hampshire, made possible by an appropriation of $5,000 by the State legislature and begun toward the close of the last fiscal year, has been continued and completed. The investigation covered the region north of Squam Lake and west to the farming lands along the Connecticut River, an area of 3,206 square miles, or approximately 34 per cent of the State. The lines followed by the investigation were—

(1) A study of the composition and quality of the forest, and an estimate of the present yield.

(2) A study of the characteristics of the more important trees and of the conditions of their successful reproduction.

(3) A study of the methods and extent of lumbering, of its effect upon the forest, and of practicable means to improve the condition of cut-over lands.

(4) An investigation of the value of the forest as a conserver of the water supply, made with the assistance of the Division of Hydrography, United States Geological Survey.

(5) A study of the magnitude, the value, and the character of the lumber industry.

The report, which will soon be published by the Bureau, includes a comprehensive and detailed description of the forest, and an exhaustive study of forest fires, with definite recommendations for fire protection. As a whole, it provides the means to answer questions of private and public policy in the management or disposition of forest lands within the region.

Hawaii.

In 1903 the legislature of Hawaii passed a bill providing for an insular forest service and creating a Board of Agriculture and Forestry, in the hands of which is placed the control of Territorial forest lands and the administration of forest affairs in the islands. Immediately upon its appointment the board sought the advice of the Bureau of Forestry in regard to the policy which should be inaugurated. The Bureau, to acquaint itself fully with the forest conditions and needs of the islands, detailed a representative to make a reconnoissance of the situation and to report with recommendations. The examination was made during August and September, 1903, and was followed by a report descriptive of the conditions and needs of the Hawaiian forests and recommending broadly a forest policy. The report was forwarded to the Board of Agriculture and Forestry, which has approved and adopted its recommendations. It was published as Bulletin No. 48 of the Bureau of Forestry and also in Vol. I, No. 4, of the Hawaiian Forester and Agriculturalist.

On the nomination of the Bureau, Mr. Ralph S. Hosmer, in charge of the forest replacement work in the Bureau, was selected by the board as superintendent of forestry, in which position he will manage, under the direction of the board, the forest affairs of the islands. Mr. Hosmer began his duties December 15, 1903, but retains connection with the Bureau of Forestry as collaborator.

Work of the Coming Year.

In California map work will be continued until the whole State has been covered; forest-fire work will be completed; studies of yield and growth of western yellow pine and sugar pine will be made; preliminary working plans for the management of State forest lands will be prepared; a study of the lumber market in the State will be undertaken; and recommendations for forest legislation and concerning the management of State forest lands will be drawn up.

FOREST LAW.

The great and increasing public interest in forest questions has led to a multitude of requests on the Bureau of Forestry for information with regard to existing forest laws, and for suggestions as to practical State laws for the encouragement of tree planting, the protection of forests against fire, and the establishment and administration of State forest reserves. Such information and advice have been given when possible, and for that purpose a careful study of forest legislation has been made during the last year. As a result, a bulletin containing an annotated compilation of the Federal and State forest laws in force July 1, 1904, together with carefully prepared suggestions based on the present experience of the Bureau, is now nearly ready for printing.

EDITORIAL WORK.

The editorial work of the Bureau includes the final revision of reports, the supervision of publications in the course of printing, and the giving out of such information of practical or educational value concerning forestry and the work of the Bureau as can best be diffused

through the periodical press of the country. It is believed that along this last line there is opportunity for a large increase in the service rendered by the Bureau as a source of useful knowledge, and steps have accordingly been taken to provide for the more frequent issue of press bulletins and to utilize more effectively this important and economical method of diffusing some of the information which the investigations of the Bureau supply.

In the revision of reports there has been a gain in effectiveness through closer internal cooperation to secure the most careful criticism, combined with plans for classifying, collating, and elaborating the material now on hand, and it is being followed by a decided increase in the amount of useful information made public by the Bureau, accompanied by the maintenance of a high standard in originality and value.

FOREST MEASUREMENTS.

Under the distribution of work in the Bureau which became effective at the beginning of the fiscal year, forest computation, forest maps, and silvics were assigned to Forest Measurements.

Forest Computation.

During the year the section of Forest Computation handled the results of 24,498 acres of valuation surveys, 33,295 analyses of trees, 16,090 height measurements, and 2,321 taper measurements. These data were collected in the preparation of eight working plans, studies of five commercial trees, two cooperative State forest studies, and five investigations of local problems in forest extension. They represent forest conditions in twelve States, and furnish information regarding thirty-nine species. Final tables of volume, height, age, and yield have so far been computed for twenty-two species. In addition to the computation of field measurements, the section now puts into final form all results which require computation obtained by the Bureau. These included during the past year, in addition to miscellaneous results, the data obtained in timber tests and in studies of the best methods for the preservation of commercial timbers. In spite of a decrease in its force, the section of Forest Computation handled notably more data in the year 1904 than in 1903.

Forest Maps.

To the section of Forest Maps is intrusted the making of maps, drawings, and diagrams, the custody of such as are not required for constant use, and the development of the best methods of mapping forest data collected by the Bureau. During the past fiscal year this section has completed approximately 250 maps and copies and 300 miscellaneous drawings. These have included the preparation of maps for working plans and planting plans, maps illustrative of the conditions influencing forest extension, and maps recording general land and forest conditions. Among the subjects illustrated by drawings and diagrams were timber-testing and wood-preserving apparatus, methods in tree planting and in forest management, and exhibits of the Bureau at the St. Louis Exposition. This work was supplemented by the plotting of valuation survey lines and forest surveys generally,

the computing of forest areas, the mounting of maps, and the classification of the map records of the Bureau.

Silvics.

The section of Silvics compiles and digests all silvic information obtained by the Bureau. This work has gone far enough to equip each man who will take up the study of a commercial tree during the coming season with a comprehensive record of the data already obtained, thus leading to added effectiveness in further work and to the early publication of results.

Work for the Ensuing Year.

The computation of the field results of the Bureau by the section of Forest Computation will continue, as will the preparation of maps, drawings, and diagrams in the section of Forest Maps. Through the section of Silvics, a definite system is being perfected and applied for the classification, under forest trees and forest regions, of all knowledge obtained by the Bureau concerning the behavior of trees in the forest.

Expenditures.

The total expenditures during the year under the head of Forest Measurements were $21,492.33, or 6 per cent of the total appropriation of the Bureau.

FOREST MANAGEMENT.

Public Lands.

The act of June 27, 1902, known as the Morris bill, provided that 231,400 acres should be selected by the Forester from certain lands of the Chippewa Indian Reservations in northern Minnesota, which should eventually become a National forest reserve. It was further specified that 200,000 acres of the designated total should be pine land, 95 per cent of the standing timber on which should be sold at public auction, to be removed under such regulations as the Forester should prescribe; that 25,000 acres should be selected from lands classed as agricultural land; and that the remainder, or ten sections, should be reserved from both settlement and the sale of timber. Work under this act has gone on steadily during the year. The ten sections have been selected and the selection has been approved by the Secretary of the Interior, their outer boundaries have been surveyed and marked plainly upon the ground, and notices against fire and cutting have been posted every 40 rods along these boundaries. The 5 per cent of timber to be left standing has been selected and marked upon approximately 55,000 acres. The timber to be removed was sold last December at public auction. In view of the fact that this timber is to be cut and removed under rules and regulations prescribed by the Bureau, it is worthy of note that the price paid for it is reported to be higher than has ever before been obtained for a considerable body of white pine timber, and in particular that it was higher than the price paid for similar timber adjacent, but not subject to the rules of the Forester.

Private Lands.

During the past year 136 applications were received for advice and assistance in the management of private forest lands under the offer of cooperation with private owners made in Circular 21. Forty-seven of these were for timber tracts, with a total area of 3,872,321 acres, and 89 were for woodlots, with a total area of 6,609 acres.

The total area of private lands for assistance in the management of which application has been made since the publication of Circular 21 is 9,500,024 acres, of which 9,478,265 acres are in timber tracts and 21,759 acres are in woodlots.

Preliminary examinations were made during the year of 25 timber tracts in the States of New Hampshire, West Virginia, Kentucky, Alabama, Louisiana, Texas, Idaho, Washington, and Wisconsin, and in the Territory of Arizona, covering a total area of 321,894 acres.

The preparation of detailed working plans for eight of these tracts was recommended and the recommendation approved by the owners. The estimated cost of these plans to the owners is $14,450.

Working plans for woodlots.

In response to applications from owners of woodland, working plans based upon thorough study on the ground were made for 68 woodlots, with a total area of 18,718 acres, in the States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, Ohio, Indiana, and Michigan. The purpose of the woodlot work is to assist the farmer or other owner in applying such management to his woodlands as will make them most productive and profitable, and to encourage by examples of forest management a more general understanding of the simpler principles of forestry. In almost every case owners have asked help of the Bureau because they had intelligent interest in the management of their forests and definite problems of their own to solve, as, for example, how and where they may best cut their annual supply of cord wood.

The wishes of the owner with regard to his forest, the amount and nature of the timber that was annually required or that could be sold, and the cost and facilities of labor and transportation are important considerations in these working plans. In every case a careful study of the forest was made on the ground. Sample areas were selected, and the trees on them were marked for cutting. These cuttings, both on the sample areas and in other portions of the forest, have in the great majority of cases been carried out at once, often with great skill and thoroughness.

Working plans for timber tracts.

The field work for detailed working plans was completed during the year upon eight tracts, with a total area of 1,068,000 acres, in Minnesota, New Hampshire, West Virginia, Alabama, and Texas. The total amount estimated as the cost of these working plans to the owners was $13,150, and the total actual cost to them was $12,539.57.

MINNESOTA.

One of these working plans was for a tract of 65,000 acres in St. Louis County, Minn. The forest, which is typical of much of the remaining pine forest of the Lake States, consists chiefly of white and Norway pines. About two-thirds of the area is pine land, and the remainder hardwood land and swamp. Nearly one-half of the merchantable pine forest has been lumbered. The lumbered lands are now totally unproductive, and future crops of timber can not be expected from them within a reasonable time.

The field work occupied a party of nine men for three months, and included a careful determination of the rate of growth and merchantable volume of white and Norway pines, and the time required to produce a second crop of merchantable timber under conservative management. It is important in the management of this tract to secure reproduction of white pine after lumbering. The working plan provides for leaving a sufficient number of seed trees to insure reproduction without appreciably curtailing the present cut of timber, and outlines a practical system for protecting the logged-off lands from fire, which is essential to the successful management of the tract.

ALABAMA.

Two timber tracts in Alabama were selected for the preparation of detailed working plans with special reference to the work which the Bureau is doing in the Southern pine belt. The working plans were completed during the year. The smaller tract covers an area of 30,000 acres, and lies in Coosa County. The larger tract comprises 75,000 acres, situated mostly in Bibb County. The forest on both tracts, which are owned by the same lumber company, consists almost entirely of longleaf pine, and is virgin timber of excellent quality. The smaller tract is now being lumbered. The timber from the two tracts will be cut at separate mills, and the lumbering will require a period of twenty-five or thirty years.

The company wishes to leave the basis for a second crop of timber, in order to lumber a second time at the close of present operations. The working plan shows that this result may be accomplished by adopting a diameter limit of 18 inches, and cutting no smaller trees.

The field work on both tracts required the services of nine men for five months, and included the actual measurement of all trees on 5 per cent of the area. One thousand felled trees were measured to determine the rate of growth of longleaf pine and the volume of trees of different diameters. These data afforded the basis for an accurate estimate of the present cut of merchantable timber, as well as of the young trees which will remain on the ground after lumbering and the annual growth of timber on cut-over lands.

The working plan recommends changes in the present methods of lumbering which will practically prevent the destruction of promising young trees and will increase the quantity and improve the quality of the next crop. It outlines an inexpensive scheme for protecting lumbered lands against fire, which will insure the successful reproduction of the pine after lumbering, and will provide for a second and successive crops of timber from the same lands.

TEXAS.

During the year the field study of a tract of longleaf pine forest in southeastern Texas, begun in 1903, was completed. The total area covered by this working plan is 800,000 acres. The collection of data this year occupied sixteen men about four months. The results secured will be of great value in preparing working plans for longleaf pine lands throughout the South.

The measurements of 8,000 felled trees afford the basis for unusually reliable tables of merchantable volume and rate of growth of longleaf pine. These tables, combined with the results of the 19,076 acres of standing timber actually calipered, give an exceedingly accurate estimate of present and future yields of merchantable timber on longleaf pine timberlands under similar conditions of growth.

A part of the work was a detailed study of the waste in logging longleaf pine, in merchantable timber left in tops, windfalls, supposed culls, and high stumps, in destruction of young growth, and in the use of thrifty trees for skid poles and corduroy. An estimate of this waste was reached by survey and measurement on 330 acres of lands recently cut over. The results show that the great bulk of the waste is in merchantable timber left in tops, which averaged 667 board feet per acre. The smallest merchantable log was taken to be 16 feet long, with a top diameter of 8 inches. Proof that this timber was merchantable was obtained by marking logs cut from a similar class of timber, following them through the mill, and grading the lumber sawed from them, which in no case ran under No. 2 common.

WEST VIRGINIA.

A working plan was made for a tract of about 60,000 acres selected from 250,000 acres of rough mountain land in West Virginia. Ten men worked in the field for a period of three months. The forest is composed of hardwoods, hemlock, and spruce. All of the hardwood and mixed hardwood and hemlock forest has been heavily cut over, and the hardwood and spruce forest has been culled. The forest of pure spruce has been cut here and there. Destructive methods of logging and forest fires have left cut-over lands in a very unsatisfactory condition. The owners wish to know whether the condition of the remaining forest is sufficiently promising and the production of timber great enough to justify further logging and holding all or a portion of the area for the future production of timber and railroad ties.

The field work included a valuation survey of the 60,000 acres selected for study, the collection of data upon the rate of growth of the principal species, and an estimate of future yields of timber under conservative forest management. The data collected in the field are now being computed, and a map is being made of the Williams River watershed, showing the yield of merchantable timber on each stream, areas recommended for immediate logging, and the location of the railroads and mills which will be necessary to market the timber.

NEW HAMPSHIRE.

A working plan was made during the year for a tract of 25,000 acres of forest and abandoned farms in Sullivan County, N. H. The field work for the working plan occupied a party of seven men two and

one-half months, and furnished an estimate of the standing timber and the rate of growth of the principal species. With these data at hand it was possible to determine the amount of timber which may be cut annually without exceeding the actual production of the forest.

Market conditions are such that this annual production can be harvested in the form of thinnings and improvement cuttings, and a system of cuttings has been outlined which will gradually better the silvicultural condition of the forest and insure the reproduction of the desirable species. The successful application of the treatment advised requires the skill of a technically trained man, and a resident forester has been engaged by the owner.

Another tract of 2,500 acres in Grafton County, N. H., presents a problem in forest management which is exceedingly common in that State. The mixed forest of spruce, balsam, and hardwoods has been largely cut over, chiefly for the softwoods. Repeated cutting has reduced the proportion of the valuable spruce. The owners propose to hold this tract for the production of timber for the boxboards which their manufacturing business requires, and wish to manage the forest in such a way that its composition will be improved and its highest productive capacity maintained.

The field work occupied a party of six men for two months. Two types of virgin forest, three types of culled forest, and three types of second growth on land formerly cleared were distinguished and carefully mapped. A detailed system of thinnings and improvement cuttings, which will favor the reproduction of softwoods and improve the composition and condition of the forest, was outlined for each type. The working plan contained also an estimate of the amount of timber which may be safely removed, and recommendations as to where cuttings should be made for the next ten years.

A third tract in New Hampshire includes 10,000 acres in Coos County, in the heart of the White Mountains. Field work on this tract required the services of four men for two months, and a forester has been engaged by the owners to direct the work of carrying out certain of the recommendations of the working plan. The forest has been lumbered for the softwoods, and has greatly deteriorated as a result of the severe fires which have followed lumbering.

The chief object of the working plan was to devise a scheme for protecting the tract against forest fires. This includes a system of patrol to prevent fire, and the construction of fire lines as bases from which to fight fires which are not discovered in time to be easily put out.

The forest types were mapped, and thinnings and reproduction cuttings for the improvement of the forest were recommended for those types in which cutting can be done without financial loss. The working plan includes an estimate of the yield of merchantable timber which can thus be cut, a plan of administration for the management of the forest, and detailed directions for work on each compartment.

Studies of Commercial Trees.

The scope of the studies of commercial trees was greatly enlarged during the year, to include, besides the determination of volume and yield, investigation of their commercial possibilities, and to make the results applicable throughout their entire commercial range.

BALSAM.

The study of the balsam fir, begun in 1902 in New York State, was continued last year in new parts of that State and extended to various localities in Maine, New Hampshire, and Vermont, thus completing the study of this tree throughout the whole range of its commercial distribution. Eight men were engaged upon this work for three months.

The study of this species was timely, because of the constantly increasing use of it by the pulp and lumber industries as a substitute for spruce. The large volume of data obtained regarding the occurrence, cut, growth, yield per acre, and fitness of balsam fir for wood pulp and lumber will furnish much information of practical value.

BIRCH AND ASPEN.

A study was made of the white birch and aspen on burned-over and cut-over land in Maine, which required the services of ten men for two months. The increasing use of both woods in the trades—particularly the use of aspen for construction purposes—has produced a demand that now gives these once worthless trees a decided commercial importance. They almost invariably seed and take possession of burned-over land before other species can obtain a foothold, and the stands are even-aged. A great many sample plots were carefully measured in stands of various ages, from seedlings coming up on land burned four months before to old trees past maturity. Averages were thus obtained for all stages of growth, from which tables of yield were made which will be of great assistance to timberland owners in managing their lands, since from them they can find just how much timber their stands contain during each five-year period from seedling to maturity.

The uses to which these woods are now put and to which they may be put were carefully studied, and tests of their physical properties were made which it is hoped may bring them into even more prominent use.

Studies of important commercial hardwoods in North Carolina and Tennessee were continued during the year, occupying ten men organized in two parties for three months.

White pine and hemlock in Tennessee were added to the commercial trees studied in the southern Appalachians.

RED GUM.

During the winter the Bureau of Forestry carried on a study of the red gum in the South. The object of this study was to find out the actual commercial value of this hitherto little used wood, and to study its reproduction, rate of growth, and silvicultural characteristics. The region covered was the hardwood bottomlands of the Mississippi River and the lowlands along the Atlantic coast. The field work covered three months, and employed ten men.

The red gum grows on the hardwood bottomlands of the southern rivers. These lands are alluvial in character, and the soil is extremely fertile, making the land of great value for agriculture when cleared and drained. The growth of all the more important species of swamp timber trees is extremely rapid, and the object of this study was in part to determine how far practical forestry could be applied to these

lands. A market study of the gum was carried on in connection with the field work, and the value of the wood and best methods of handling it were ascertained. In the past the gum has been considered a very inferior wood because of the difficulties in handling and seasoning it. The boards tend to warp and twist. By care in drying, however, these defects can largely be overcome, and it is hoped that the present study will be of value in establishing this wood more firmly on the market. The wood is used chiefly for boxes, flooring, furniture, and interior finishings.

RAILROAD TIES.

The available supply of timber for railroad ties is rapidly dwindling away, and therefore it grows more important every day to find a cheap and still abundant material. With this aim in view the study of loblolly pine, which has been carried on in many parts of the South, was taken up in Texas, where the great area of young growth of loblolly pine furnished for this purpose an unexcelled opportunity. Particular attention was paid to the yield of loblolly pine land in ties and the advisability of holding it as a permanent investment for raising tie timber, as well as to the possibilities of avoiding the waste coupled with tie making and introducing economical methods of management of loblolly pine forests for ties.

THE MONEY VALUE OF A TREE.

A piece of work along entirely new lines is the determination of the money values of trees of different sizes, by selecting trees in the woods and following the logs through the mill to learn the amounts and grades of lumber they saw out. The result is a striking demonstration of the rapid yearly increase of small trees in actual cash value, and hence of the wisdom of preserving them. This determination has now been made for longleaf pine in Alabama and Louisiana, and for yellow birch, sugar maple, and beech in New York.

WORK FOR THE ENSUING YEAR.

WORKING PLANS.

At least eight working plans will be prepared during the coming year. They are as follows:

A working plan for a small tract in New Hampshire, chiefly important for the excellent opportunity it will afford to study methods of logging the mixed forest of white pine and hardwoods in such a way as to increase the proportion of the valuable white pine in the next crop. Under proper management the natural reproduction of white pine may be greatly increased.

Two working plans for tracts in West Virginia, where the important problem of management is to provide a continued supply of cheap mining timbers. The chief object of the working plans will be to devise a system of logging by which the annual requirement for mining timbers can be supplied without overcutting the forest.

A working plan in Kentucky for a tract of 40,000 acres of hardwood forest, which the owners wish to hold mainly for the permanent production of railroad ties. This is a problem which is rapidly assuming

importance, but as yet little accurate information is available on the subject.

A working plan in Alabama, including a study of less wasteful methods of lumbering white oak and hickory.

Conservative management of a forest of mountain cedar is the chief problem of a working plan for a tract of 20,000 acres in Paloduro Canyon, in western Texas. Wise use of the forests of this valuable tree is a matter of the greatest importance over a vast area of otherwise treeless country in the Southwest.

Two working plans, one in Washington and one in Idaho, will be made for very large tracts, in one case of two million acres, and in the other of over one million. The problem here is not, as is often the case in the East, so much to increase the yield of the forest as it is to devise modifications of logging which will prevent the total destruction of the productiveness of lumbered lands. These working plans afford the opportunity to make practical application of the studies of those Western commercial trees which the Bureau has made as the foundation for effective work in actual management. Continued attention will be given to the preparation of working plans for woodlots. The unique opening which this line of work affords for spreading among small owners, whose holdings are so important in the aggregate, a knowledge of how to get the most out of their woodland, gives special importance to these studies.

STUDIES OF COMMERCIAL TREES.

The purpose of the Bureau in its commercial tree work during the coming year is to complete as rapidly as possible the studies of those trees for which sufficient mathematical data have been collected. This will be done by giving to trained men the task of making practical application to specific problems of the large amount of information now on hand. The studies to be thus completed during the year are for yellow poplar, white, black, red, and chestnut oaks in the South, sugar pine in California, lodgepole pine in Montana and Idaho, and western yellow pine.

EXPENDITURES.

The total expenditures during the year under the head of Forest Management were $42,636.67, or 12 per cent of the total appropriation of the Bureau.

DENDROLOGY.

Forest Distribution and Resources.

FORESTS IN LONG ISLAND COUNTIES.

A descriptive forest study of Suffolk and Nassau counties, Long Island, N. Y., was begun and completed during the year. Its object was to supply information as to the desirability of a State forest reserve in that region. The report will be accompanied by a type forest map, and will contain the results of a thorough study of the forest conditions of these counties, with special attention to the economic value and importance of existing forest growth as a protection to local water supply.

MISSOURI SWAMP FORESTS.

A report which concludes the study of Missouri swamp forests in progress at the beginning of the fiscal year was completed on June 30, 1904. It contains a discussion of the influences which affect the distribution and growth of bald cypress, red gum (Liquidambar), and black gum and cotton gum (Nyssa). The information given will be of value in connection with other investigations of these species, and forms a useful contribution to a knowledge of the little known silvical requirements of these commercially important trees.

CALIFORNIA BIG TREES AND BRISTLE-CONE FIR.

Field studies have been finished and progress has been made toward the completion of reports on the above California species.

PACIFIC COAST TANBARK TREES.

The study of the distribution of Western tanbark oaks and of other tanbark trees was continued, together with a study of the tanning industry dependent upon these trees for tanning materials. Particular attention was given to mapping the range of the principal tanbark oak of the coast region and to the available stand, silvical requirements, and aids to reproduction on cut-over areas. Upon this information will be based important recommendations for a sustained yield of a tanning material which is indispensable to the Pacific leather industry.

Through hearty cooperation of Pacific bark dealers and tanners, a very large number of bark samples was collected for chemical analyses, which have been made by the Bureau of Chemistry. The unexpected discovery of several different types of bark, which yield widely varying quantities of tannin, led to the extension of the study considerably beyond the original plan of investigation. This study should prove exceptionally profitable in determining the requirements and the special forms of this species which produce the largest percentage of tannin.

In connection with a study of various oak barks much used to adulterate the standard bark, one or two untried kinds were found which are of genuine value. The possible future use of the abundant alder barks of the coast region has also been under investigation.

OHIO HARDWOOD FORESTS.

The study of this subject was terminated during the year. Valuable notes and data resulting from experiments on the water content of green and of air-dried saturated woods were secured.

TURPENTINE ORCHARDING.

The work, which the Bureau undertook three years ago, of replacing the ruinous "box" system of turpentining by a less injurious but equally productive system has been practically completed. The actual results obtained under the cup and gutter system are far beyond what was anticipated. They consist in a yield of nearly 40 per cent more turpen-

tine by the new than by the old method, the production of uniformly high grades of rosin, and, what is of the most vital importance to a continued existence of the American naval stores industry, in an indefinitely prolonged working life of turpentine orchards. The old system of turpentining was rapidly exterminating the pine forests tapped, and extinction of the naval stores industry was acknowledged by intelligent operators to be imminent. On a conservative estimate the Bureau's service in this work has added to the annual naval stores product an increased value of about $7,000,000, at a total cost of less than $14,000, and in addition has removed the greatest single cause of Southern forest destruction. The new system is now in very general use throughout the turpentine belt, and in the hands of as many operators as could secure the required equipment.

TURPENTINE DISTILLATION.

A study of European methods of distilling crude resin was made abroad during the year, and it has shown the need of experiments here for the purpose of improving American stills, which at best give unnecessarily impure spirits. Rosin and rosin oil are, through faulty construction and manipulation of our stills, commonly driven off with spirits of turpentine, thus becoming impurities in the latter. The presence of these was discovered when the Bureau began its preliminary studies of turpentine adulterants. The most improved turpentine stills in France are fitted with thermostatic regulators and operated by men of trained intelligence. The result is that uniformly pure grades of spirits and rosin are produced. The majority of American stills are without temperature gauges, and are operated by untrained men who have merely learned to apply certain rough, empirical tests. The results are impure and varying grades of spirits and rosin.

The distillation of rosin oil was found to be a paying and extensive industry in European countries. American consumers at present import nearly all of the considerable quantities of rosin oil used here. It is believed that this demand could be profitably supplied by home production.

DENDRO-CHEMICAL INVESTIGATIONS.

A laboratory study of turpentine adulterants was concluded in August, 1903, and the preparation of a report on methods of detecting their presence is under way. The subject is one of much importance to naval-stores dealers, who are now greatly embarrassed by their inability to detect spurious turpentine. The results of laboratory studies of native and exotic gums, resins, tanbarks, and pulp-wood fibers have been embodied in a report by Dr. H. W. Wiley, Chief of the Bureau of Chemistry, which concludes the investigations begun in cooperation by the Bureaus of Chemistry and Forestry three years ago.

BASKET WILLOW STUDIES.

A half-acre plantation of 5,000 willow cuttings established on the Potomac Flats in the spring of 1903 for the purpose of testing the fitness of different native and exotic kinds for basket work, and particularly for determining the relation of close and wide planting to the production of high-class basket rods, yielded valuable results, which were em-

bodied in a bulletin on the basket-willow industry. Further plantings on the Arlington Experimental Farm have permitted a wider range of experiments, which are establishing other important facts. It is intended to embody these in a circular to be issued during the coming winter.

STUDY OF SUGAR-MAPLE GROVES.

A careful field study was made in the eastern sugar-making districts of the needs of typical old forest-grown sugar-maple groves, and of the treatment required to convert dense seedling and pole-maple thickets into future sugar bushes. The results form the basis of helpful instructions which have been incorporated in the bulletin on the maple-sugar industry previously prepared for printing.

EXPOSITIONS.

The Bureau's forest exhibit at the Louisiana Purchase Exposition, St. Louis, Mo., was installed in May, 1904. An indoor exhibit covers 5,000 square feet of floor space and comprises some 12 special features. Large photographic transparencies and colored bromide enlargements, relief maps, charts, timber and other specimens, instruments, etc., afford a complete survey of typical forest conditions and of the use of the forest and its destruction in the United States, as well as an exposition of the principles and practice of forestry as applied by the Bureau of Forestry. An outdoor exhibit covering 2½ acres illustrates tree-planting plans for farm woodlots and windbreaks adapted to different parts of the country and forest nursery methods. The allotment for preparing the display was $7,500.

FOREST LIBRARY AND PHOTOGRAPHS.

The forest library contains 4,227 books and pamphlets, of which 543 were added this year. The forest photographic collection comprises 13,800 mounted and classified pictures and 2,320 lantern slides; 4,384 photographs and 502 slides were added this year. Photographs are taken in connection with the Bureau's field work, and constitute invaluable records for reference.

During the year 1,676 photographs (mainly unmounted) were given to educational institutions and to individuals for use in illustrating books and magazines and newspaper articles on forest subjects and in educational work, and 635 lantern slides were loaned. The requests for loans and gifts were from 27 States and 4 foreign countries and from 26 educational institutions.

Foreign forest photographs were obtained by exchanging sets of American pictures for those of other countries. Seventy-five sets of our photographs were sent and 73 sets received in exchange. In addition, upward of 200 foreign and home pictures have been presented to the collection by correspondents and friends of the Bureau. Notable among these is a valuable set of Chilean pictures from Mr. H. J. Elwes, of London, England; Georgia, Florida, and Texas views from Mr. R. M. Harper; and photographs of Michigan pine forests from the State agricultural college. A tabular record of the regions and subjects covered by the Bureau's photographs, now in preparation, will assist a system-

atic extension of photographic records over regions not now covered, and at the same time will prevent useless duplication. The photographic laboratory work will hereafter be in charge of the Office of Records.

Correspondence.

Three thousand eight hundred and fifty communications were prepared in response to correspondence, as against 3,650 the preceding year. A large number of wood and other tree specimens were received for identification, particularly from manufacturers, builders, and architects. Repeated attempts of certain manufacturers and contractors to substitute spurious for standard wood materials led to appeals to the Bureau of Forestry for expert information, which has been promptly given. Several serious impositions upon consumers have thus been averted.

Expenditures.

The total expenditures during the year under the head of Dendrology were $24,155.97, or 7 per cent of the total appropriation of the Bureau.

Work for the Ensuing Year.

A revision of Bulletin No. 17, "Check list of the forest trees of the United States," will be made to secure the addition of new and hitherto unrecorded tree species, the revision and extension of the list of common names of trees, and a revised statement of the geographical ranges of trees. Brief popular descriptions of species will constitute a new feature of the revised bulletin.

A series of bulletins descriptive and illustrative of indigenous and naturalized tree species in the United States will be begun.

A study of the acacias growing in the United States will be continued. Special attention will be given to the identification of species, their requirements with respect to soil and climate, and the economic uses of their wood and bark. The species which grow here give promise of great usefulness in arid southwestern regions because of their rapid production of fuel and their excellent tanbark.

Another study proposed is that of eucalypts suitable for cultivation in regions of little frost. A number of species of economic use are believed to be adapted for growth in the South Atlantic and Gulf States, and possibly in the Middle States, in which the species now cultivated in this country can not be successfully grown. The preparation of a bulletin descriptive and illustrative of these eucalypts is planned.

The range, habitat, and future usefulness of the insufficiently known Parry pine, Torrey pine, and swamp pine will be investigated. The ability of these trees to thrive and to propagate unaided both in extremely arid and in wet situations, unsuitable for other species, indicates their great usefulness for cultivation in treeless regions of the Southwest.

A study will be made of the range, habitat, and reproduction of cascara buckthorn, and of the relation of the existing stand to the demand for and production of bark. This little-known tree has become highly important in Oregon and Washington for the commer-

cial value of its bark, for which there is a widespread, permanent, and increasing demand. The extensive collection of bark now threatens the commercial disappearance if not the complete extermination of the species. Consumers are extremely solicitous for the future of an established industry. A careful investigation would permit recommendations looking to a maintenance of the supply.

Experiments will be made to determine the minimum wound necessary in tapping pine trees to produce a maximum yield of turpentine and rosin. It is believed that the experiments planned will result in a system of chipping which will increase the life of turpentined trees without decreasing their yield of naval stores.

Experiments with basket willows will be continued on the Arlington Experimental Farm to determine the best methods of culture and spacing for the production of high-grade basket rods. Both native and exotic willows will be tested with special reference to the soil and management required to secure the best quality and largest yield of stock. Methods of harvesting and preparing rods for market will also be studied, as well as the market value of each species.

FOREST EXTENSION.

Cooperative Planting.

The policy of cooperation with private owners in forest planting has been in force in the Bureau since July, 1899. Up to June 30, 1904, an aggregate of 345 examinations of separate pieces of land were made to determine their suitability for planting, followed by the preparation of 334 plans, for land in thirty-six States and Territories, with a total area of 13,668.8 acres. The cost of these plans was approximately 35 cents per acre. During the past year the Bureau examined land belonging to 53 owners and made 42 planting plans for an aggregate of 2,861.33 acres. Forty applications were on file awaiting attention at the beginning of the year, 65 were received during the year, and 52 are now awaiting attention.

The following table shows in detail the number of examinations and plans made, and the total area covered by the plans, by States, for the past year and since the inauguration of cooperative planting.

Planting plans.

State.	July 1, 1903, to June 30, 1904.			Total to June 30, 1904.		
	Examinations made.	Plans made.	Area.	Examinations made.	Plans made.	Area.
			Acres.			*Acres.*
Alabama				2	2	740
California	3	2	6	7	6	216.95
Colorado	1	1	4.55	13	13	56.30
Connecticut	1	2	150	9	9	410.13
District of Columbia	1	1	1	2	2	46
Florida				1	1	650
Illinois	1	1	9	5	5	89
Indian Territory				2	2	29.50
Indiana				12	12	1,038
Iowa				8	8	42.90
Kansas	4	4	181	48	48	928
Kentucky	2			2		
Maine				1	1	700
Maryland	1	1	1	1	1	1
Massachusetts				13	12	1,939.50
Michigan	2	1	1	8	7	320
Minnesota				9	9	48
Missouri	1	1	2.50	2	2	7.50
Nebraska	3	3	7.13	26	26	197.99
New Hampshire				5	5	84
New Jersey	2	1	45	2	1	45
New Mexico	1	1	131.88	3	3	571.88
New York	3	2	1,200	9	8	1,330.80
North Carolina				2	2	280
North Dakota				27	27	187.62
Ohio	7	6	181	11	10	198.40
Oklahoma	3	3	25.50	28	28	298.18
Pennsylvania	3	3	223.77	10	10	929.49
Rhode Island				4	4	289.20
South Carolina				2	2	100
South Dakota				31	31	352.23
Texas	4	2	128	22	21	284.23
Vermont	1	1	34	4	4	588
Virginia	4	4	63	6	6	159
Washington	1			1		
West Virginia	4	3	170	5	4	480
Wisconsin				2	2	130
Total	53	42	2,861.33	345	334	13,668.80

The Bureau does not furnish seeds or trees for cooperative planting. It participates in the expenses of planting only to the extent of defraying the salaries and, in certain cases, expenses for travel and subsistence of its agents while making the planting plan. Nor does it undertake to make either planting or working plans for all applicants.

Preference in time of examination is given to those applications which are likely to afford the most useful object lessons. When an application has been made and accepted, an examination of the land which it is proposed to plant is made by an agent of the Bureau. Upon small areas where prolonged study or the services of assistants are not required, a planting plan, if planting is recommended, is prepared by the agent before leaving the ground. In all cases the conclusions of the examination as to the advisability of planting are embodied in a report to the owner. If the preparation of a planting plan is recommended and the recommendation accepted, a thorough study is made on the ground and a detailed and comprehensive plan prepared, a copy of which, with all essential measurements, maps, and other data, is sent to the owner upon completion.

In July, 1903, reports from 118 persons for whom planting plans, covering 3,704 acres, had been made showed that 21 per cent of the area had been planted, and that on 2,352 acres more, or 63 per cent, the plans are considered valid. Plans for an aggregate of 550 acres

were abandoned or doubtful of execution. The ultimate planting of from 50 to 75 per cent of the area covered by the plans is to be expected.

In the past the method followed has been to send an agent to any locality after a sufficient number of applications have been received to warrant the expenditure. In addition, a plan of systematic regional studies has now been put into effect, the purpose of which is to enable the Bureau to handle by correspondence, as fast as the studies are completed, the applications for assistance, except in undertakings of special difficulty or unusual magnitude.

Examinations of two distinct regions made during the year resulted in the preparation of representative planting plans applicable to a large number of cases. The first was the plains of eastern New Mexico and western Texas. It is known that as a result of this plan 300,000 trees were planted on 237 acres in the region. The second examination covered the flood-damaged lands along the Kansas River, and resulted in the publication of Circular No. 27 on the "Reclamation of flood-damaged lands in the Kansas River Valley by forest planting." Copies of this circular were distributed to the farmers of the devastated district. A planting plan for the reclamation of these lands has been prepared and is sent to those who make application to the Bureau for assistance.

The planted timber of that portion of Kansas lying west of the ninety-ninth meridian was also studied during the past season. A large number of groves were measured, and from the copious notes secured in the investigation and previously a report of great practical importance to farmers of that region has been prepared and is being published as a bulletin.

Reports are now in preparation upon other field studies made in northwestern Texas, Oklahoma, Kansas, and western Nebraska. Field studies are being extended to other districts where they are urgently needed.

Along the same line sixteen circulars on the planting and growing of the commonly planted trees were printed during the year, and material for twenty others is now available. It is designed, when the remaining important species have been so treated, to embody the circulars in bulletins, each applicable to a definite region.

PUBLIC LECTURES.

In connection with the cooperative planting work sixteen public meetings were held in the Middle West for the discussion of tree-planting problems. In August, 1903, a course of six lectures was given before the Old Salem Chautauqua Association at Petersboro, Ill. Courses of about the same length were given at the South Dakota School of Mines and the University of Texas. Papers were also read before the Kansas Horticultural Society.

World's Fair Exhibit.

A field exhibit of forest planting has been installed and is being maintained at the Louisiana Purchase Exposition. The exhibit covers 2½ acres of ground and is in three parts. The first part consists of a model prairie farm laid out with suitable wind-breaks. The second part is a series of woodlots planned to show suitable trees for planting

in various sections of the United States. The third part consists of a demonstration of simple nursery methods applicable to the growing of forest seedlings in small numbers such as may be wanted on the average farm.

Reserve Planting.

DISMAL RIVER RESERVE.

In the spring of 1903 planting was begun on the Dismal River Reserve, in west-central Nebraska, by setting out 30,000 western yellow pine and 70,000 jack pine forest-grown seedlings. The yellow pine had been collected in the Black Hills the previous autumn, the jack pine in Minnesota in the spring of 1903. The yellow pine suffered great exposure in shipment, and failed entirely. Of the jack pine about 35 per cent survived. The trees were set in deep incisions made with a spade in the loose sand of the sandhills, without previous preparation of the soil.

The seedlings which were set in bare spots have grown far better than those set in the protection of grass and shrubs, probably on account of the more abundant moisture. All which survived last year started into vigorous growth early this spring. Many had grown 6 inches by May 25.

Several methods of seeding direct in the sandhills, such as broadcast sowing and seeding in hills by means of a hand corn planter, have been tried in the hope of finding rapid and economical methods of forestation, but without apparent result. As more favorable conditions than those under which the work has been done can scarcely be expected, the indications are that seeding can not be made successful.

Better results have been realized from growing seedlings in a nursery. The first seedbed, 1 acre in area, was planted in the fall of 1902 and spring of 1903, from seed gathered by the Bureau. The cost of raising 575,000 one-year-old seedlings in this seedbed was $1.20 per thousand. This includes collecting and planting the seed, cultivation and mulching, and one-tenth of the cost of clearing the ground and constructing the shade frames.

In the nursery the western yellow pine and piñon seedlings attained the first year the height of 3 inches, and produced finely developed roots 12 to 15 inches long. In the spring of 1904, 300,000 of these seedlings were planted on 335 acres, the trees being set at 6-foot intervals in the bottom of furrows plowed 8 feet apart. The cost of this planting was $746.95, or $2.48 per thousand. Adding to this the cost of growing the seedlings, $1.20 per thousand, the total cost for growing and planting was $3.68 per thousand. A high efficiency of labor was secured by careful systematization, and the whole operation was carried out with a combined attention to essential requirements, readiness in contriving practical methods, and economy, which make its execution an object lesson for similar work.

On June 6 counts were made on four sample-acre plots to determine the number of living trees. On three plots of western yellow pine 91, 90½, and 95 per cent were living and growing. On the fourth acre, which was of piñon, 94 per cent were living and growing.

In September and October, 1903, an acre of ground was cleared and prepared for an additional seedbed, at a cost of $77. The bed was then covered with woven-slat fencing which provides half shade, at a

cost of $1,363.09. In November, 1903, the new seedbed was planted to western yellow, jack, and lodgepole pine, and red and white fir, in drills 6 inches apart, at the rate of 50 to 60 seeds per linear foot. Planting the 1 acre required 25½ days' work and cost $44.62. This very low cost was the result of ingenious and labor-saving methods, and it is believed to compare very favorably with what any private nurseryman could accomplish the same work for. The bed from which the seedlings were taken for this year's planting has been seeded again, giving 2 full acres of seedbed, most of which will furnish trees for planting next spring. With ordinary conditions, 1,500,000 trees should be ready for planting at that time.

BRUNER PLANTATION THINNED.

This plantation, situated in the southwestern part of Holt County, Nebr., was planted under the direction of the Division of Forestry in 1890. It consists principally of jack pine. Its marked success has greatly influenced planting on the Dismal River Reserve and elsewhere on the Plains. As the trees had been thickly planted and never thinned, they had crowded so severely that to preserve the best growing condition it was necessary to thin the plantation during the past year. In this grove the dominant trees average 19.4 feet in height, and 3 inches in diameter breasthigh. The thinning has left the trees in excellent condition, and they should continue, if not excel, their good growth of the past.

NIOBRARA RESERVE.

This reserve also is situated in the sandhill region of Nebraska, and was established for the purpose of giving opportunity for large experiments in tree planting.

During the past year the reserve was surveyed and mapped. A report was made which includes, besides a description of conditions, recommendations for the protection of the present timber and for planting.

SAN GABRIEL RESERVE.

Planting on the San Gabriel Reserve, though in progress experimentally under the Bureau's direction for three years, has not yet resulted in the discovery of a sure and economical method of securing its forestation. A year ago the method of seed-spot planting was given a thorough trial. Seed so planted germinated readily, but the young seedlings were nearly all destroyed by birds and rabbits when only a few days old. A few hundred seedlings were also planted. These were very young and tender and nearly all died, but their endurance in transplanting indicated the probability of success with larger transplanted trees. A seedbed was therefore established in Pasadena, as stated in last year's report, and has resulted in 50,000 thrifty trees, 35,000 of which have already been transplanted, and all of which should be in prime condition for transplanting on the mountains next winter.

It was decided to establish a nursery also at a higher elevation, near where the planting should be done, and accordingly a site was chosen in the San Gabriel Mountains, on a bench 2,500 feet above sea level, known as Henninger's Flats. The tract, consisting of 80 acres, with

water right, is leased from the Mount Wilson Toll Road Company. A reservoir with a capacity of 23,000 gallons is situated 250 feet above and 1,700 feet distant from the nursery. The company furnishes with the land a cottage of four rooms and a stable.

The site of the nursery was cleared, grubbed, plowed, cleaned of roots and rocks, and fenced with rabbit-proof wire netting. A seedbed 48 by 160 feet was prepared. It is now covered by a stationary lath shade, 6 feet above ground, made to permit half sunlight, the cost of which was $219.80.

The area within the frame was seeded in the latter part of March to bigcone spruce, Coulter pine, knobcone pine, incense cedar, sugar pine, Jeffrey pine, gray pine, deodar, piñon, and Monterey pine. A small quantity of each of these species, together with some of the largest species of chaparral, was also planted in open ground, to determine their ability to stand direct sunshine in germination.

Thirty thousand trees have been transplanted from the seedbed in Pasadena to the nursery at Henninger's Flats, with a loss not exceeding 3 per cent.

PIKES PEAK RESERVE.

The study of forest replacement on the Pikes Peak Reserve, described elsewhere, has prepared the way for the establishment of small nurseries and the beginning of experimental planting on that reserve. A report which is now in preparation describes in detail areas on which planting is recommended, discusses the trees which should be used, and locates available nursery sites. The beginning of planting forms the subject of a recommendation for next year's work.

SEED COLLECTING.

The seed used on the reserves has all been collected by the Bureau. An abundant crop in the case of several species which the Bureau is planting extensively, and in which seed production is irregular, made it desirable to collect in quantities beyond the needs of the current year. A total of 5,350 pounds of seed was collected in California, Colorado, Michigan, Minnesota, and New Mexico, of western yellow and Jeffrey pine, goldencup oak, simpleleaf sumach, bigcone spruce, jack pine, knobcone pine, hollyleaf cherry, red fir, white fir, and sugar pine.

FOREST REPLACEMENT.

Studies of the action of the forest in reoccupying ground which had been denuded of trees have been carried on in Colorado, Kansas, New Mexico, and southern New England.

An examination of the problem of reforestation on the Pikes Peak Reserve, Colo., was conducted on the watershed which supplies Colorado Springs, in the southern part of the reserve. Attention was mainly given to the history of fires which denuded the mountains, the distribution of young growth which has succeeded fires, the productive power and rate of growth of the principal trees, the conditions which influence forest replacement on the burned areas at high altitudes, and the necessity of supplementing natural reproduction by planting.

The study shows that the most serious fires took place at least fifty years ago, and that some of the burns have been fairly stocked with

valuable young trees, while others have been occupied by quaking aspen, and still others have remained practically barren. The young trees are irregularly distributed and grow slowly. Unless planting is resorted to, there is no hope for a restoration of the forest on some slopes within a reasonable time.

A map is being made to show the distribution of old and young timber in relation to this very important watershed, the location of areas naturally reforesting, and the tracts, practically devoid of reproduction, upon which planting is recommended.

Coordinate with the study of planted timber in western Kansas, an examination was made of the tendency of the narrow belts of natural timber which border the streams to wrest from the prairie contiguous tracts of ground, now that prairie fires, less frequent than formerly, no longer give grass the advantage over forest which it once had. The object of the study is to direct attention to the latent tendency toward forest extension and to its manifest value in the region. A similar study has been completed in western Nebraska, and a report for the two regions is now awaiting publication.

A tract of 200,000 acres, comprising most of the watershed of the Vermejo River, in northern New Mexico, was studied for the purpose of finding methods of improving the reproduction of the forest, which consists mainly of an open stand of western yellow pine, deficient in reproduction on account of fire, excessive grazing, and insufficient seed. Plans were made to repair the damage from fire and stock, and a series of experimental plantations was recommended. The experiment should show what methods are most successful and economical for establishing the stand of timber required.

For the past two field seasons a study of the replacement of white pine on old fields and pastures in central New England has been under way. Field work which has been completed has yielded data of scientific interest and high practical importance. Around three different centers in New England the tendency of white pine to take possession of abandoned farm lands is so strong that it may be depended upon by the landowner to restock his land with forest without any effort on his part.

Forest Fires.

Work of large practical public benefit was a study of the extent and effect of great forest fires, such as those in Washington and Oregon in 1902, and of fires in the Adirondacks in 1903.

So serious were the fires in the Adirondack Mountains from April 20 to June 8, 1903, that the Bureau without delay began a study on the ground of their extent, causes, and effects. Agents of the Bureau traveled extensively through the region, made careful examinations of many of the burned areas, and gathered information from guides, cruisers, lumbermen, pulp manufacturers, and superintendents of private preserves. Reports were also obtained from the fire wardens of all towns within or near the Adirondack Park. A careful study of the burned-over lands along the lines of the New York Central and the Delaware and Hudson railroads was also made.

It was found that over 600,000 acres of timberland were burned over. About $175,000 had been spent in fighting the fires. The total direct loss from these fires was approximately $3,500,000, with an incalculable indirect loss, due both to the destruction of young growth

which was to form the future forest and to the injury to the forest soil from the burning out of its humus. A summary of the information gathered was published by the Bureau as Circular No. 26. The circular has been most useful not only in supplying information to a deeply concerned public, but also in giving the legislature of the State of New York a sound basis for undertaking needed improvements in the State system of fire protection.

Dunes.

The application of forestry to the reclamation of shifting sand was considered during the past year, principally in connection with the sandhill districts of southern Michigan, where a small party worked for two months gathering data on the extent of shifting sand and the trees and shrubs which are adapted to grow upon it. Methods of reclamation which have been employed were closely examined. Opportunity has not yet been afforded to put the data which have been obtained on this subject into form for publication. Until this can be accomplished field work will be suspended.

Additional Cooperative Work.

The office of Forest Extension participated in several lines of work described under State Cooperative Studies. It made the examination of the Hawaiian forests, and conducted the work in cooperation with the Massachusetts Forestry Association. It also conducted the investigations of the growth and value of planted eucalyptus, of forest replacement, and of chaparral conditions and their improvement in southern California, carried on by the Bureau in cooperation with the State of California, as well as the work done toward the inauguration of an effective forest-fire policy for that State.

Expenditures.

The expenditures in forest extension during the past year amounted to $57,119.19, or 16 per cent of the appropriation of the Bureau.

Work for the Ensuing Year.

The making of planting plans under the slightly modified plan of cooperation will continue during the ensuing year. Field studies for extensive planting plans will be made of Griffith Park, near Los Angeles, Cal., and parts of the Paloduro Canyon, in northwestern Texas. Studies of the success of planted timber will be made in eastern Nebraska, eastern North and South Dakota, and northern Illinois.

Planting will be extended on the Dismal River Reserve, continued on the San Gabriel Reserve, and begun on the Pikes Peak Reserve. Study will be made of the replacement of the forest on the Salt Lake Reserve, which may lead to the beginning of planting there. The studies in progress on forest replacement and chaparral conditions in southern California will be concluded and the data compiled for publication. In connection with the study of the success of planted timber in Nebraska, North Dakota, South Dakota, and Illinois, examination will be made of the encroachment of the natural forest upon new areas. The study of methods of controlling forest fires in California will be

completed, and the recommendations resulting from it will be presented to the State legislature for its consideration.

FOREST PRODUCTS.

General Aim of Work.

Work under Forest Products during the past year followed two lines: First, studies of methods of timber preservation; and, second, tests to determine the strength of timbers. Timber-preservation studies were grouped by regions into Western, Central, and Eastern. The timber test work was conducted at New Haven, Conn., Washington, D. C., Lafayette, Ind., and Berkeley, Cal.

In addition, a three-months' investigation was made by the chief of the division in various European countries, of the methods there in use for seasoning and treating woods and for fastening rails to ties. The latter subject is one of vital importance in connection with the use of soft timbers in the United States at the present time. A large amount of information was collected, part of which was published in Bulletin No. 50 of the Bureau. A further bulletin is in preparation dealing with some problems relating to treatment. As a result of this trip, tests are now being made in various parts of the United States to determine methods for more economically treating timber and to ascertain how screw-spikes and screw-dowels may be made to increase the service of softwood ties.

An obscure cause of deterioration of ties treated with zinc chlorid, when laid in the track, was made the subject of investigation. A deleterious action which had been observed to affect both the tie and the spike, and which was ascribed to a supposed production of hydrochloric acid, was found to be really due entirely to electrolysis. Microscopic study of spikes from various mills which were found to behave differently from one another led to further discoveries which indicate that in the light of these experiments makers of spikes can be so instructed as to produce, at a cost not greater than that now paid for the ordinary spike, a spike which will entirely resist the action of zinc chlorid.

An investigation of the production and use of creosote oils in this country and in Canada, and of the causes of their differences in quality, has brought out the fact that these differences are due to different methods both of treating the coals and of distilling the coal tar. It has also disclosed that market conditions in this country are at present unfavorable to the production of very high grade oils here, because such oils must be distilled at a high temperature. Pitch and creosote oil are both products of the same operation, and distillation at a high temperature ruins the soft pitch which is now in great demand here, and produces a hard pitch which can not here, as it can abroad, be profitably marketed. With a market for hard pitch, high-grade oils could be obtained.

It was found that the large Canadian supply of these oils which exists is unfortunately of such a character that its use can not be recommended excepting for the impregnation of railroad ties.

One of the most difficult tasks which this office has undertaken has to deal with the action of various chemicals on wood. Numerous experiments were carried on in order to test the formation of insoluble

compounds in wood, and also the action of the timber-destroying organisms on such compounds. The investigations are complex in character, but their practical import is the light which they shed on the various problems of wood preservation.

In consequence of the discovery that the methods of analysis employed by various chemists to determine the amount of zinc chlorid in samples of treated timber do not secure uniform results, the cause of the variation was investigated and discovered, and new methods were proposed which will avoid the error.

Studies in Timber Preservation.

WESTERN.

This work consisted of seasoning and treatment tests of certain inferior woods. The use of many of the inferior woods in the West will depend upon successful methods for drying them rapidly and evenly so as to prevent decay, excessive checking, and warping. With the rapidly increasing use of the softer woods, the Bureau was called upon to give information concerning them, particularly as to how to prevent rapid decay. During the past year ties of various timbers were experimented with. The reasons for selecting ties for these experiments were that large numbers were obtainable, without cost to the Bureau, from various railroad companies interested in the results, that the subject of tie preservation is in itself of main importance, and that in this way conclusions of general application may be secured.

Tests were made of ties of the following woods: Longleaf, shortleaf, and loblolly pine, at Silsbee and Somerville, Tex.; red and black pine, spruce, and fir, at Rociada, Las Vegas, and Pecos, N. Mex.; lodgepole pine, at Sheridan, Wyo., and Bozeman, Mont.; and fir, at Tacoma and Pasco, Wash.

TESTS OF LOBLOLLY AND SHORTLEAF PINES IN TEXAS.

The loblolly pine investigations at Silsbee, Tex., were carried on in cooperation with the Atchison, Topeka and Santa Fe Railroad. It has been commonly supposed that loblolly pine timber could not be held successfully for any length of time before use. Various species of fungi attack the wood very soon after cutting, and render it valueless with great rapidity. In the tests at Silsbee 500 ties of loblolly pine were cut every month, and weighed immediately. They were then piled in open piles of various forms, some with and some without a roof. All ties were reweighed at regular monthly intervals to determine their rate of drying. The same process was carried on with shortleaf pine, and to a certain extent with longleaf pine.

As a result of the year's work it can be asserted that loblolly pine timber when properly piled can be held in Texas for eight months or more without decaying. In that time it will lose approximately 40 per cent of its weight by the evaporation of the water contained in the wood. These results have an important bearing upon the use of loblolly pine. A bulletin on this subject is in preparation.

Further experiments with methods of piling loblolly were carried on at Somerville, Tex. Some 250,000 sawed and hewed ties were piled in various ways to determine the possibility both of reducing the cost

of handling and of forming piles which more rapidly dry out the timber. It is believed that a form of pile extensively used in Germany was proved to be not only a better form of pile for seasoning the ties, but somewhat more economical than the old form. A report as to the result of these tests was prepared.

In connection with the seasoning of loblolly pine, treatment tests also were carried on at Somerville. These related chiefly to details in the manner of treating this timber with zinc chlorid. It was thought that by omitting the steaming process a more favorable penetration could be obtained. These tests have simply been begun, only 2,500 ties having been treated, but have so far shown a greater absorption by weight when ties are steamed than when the steaming process was omitted.

TESTS OF NEW MEXICO PINES.

Two stations for tests of seasoning and one for tests of treatment of New Mexico pines were established during the year. The seasoning tests were conducted at Pecos and Rociada, N. Mex. Eight thousand ties of western yellow pine, balsam, and spruce, cut in the vicinity of the former place, and some 4,500 of western yellow pine, spruce, and white fir near the latter were weighed at monthly intervals to determine their rate of seasoning. Some of them dried out in four months. The general results show that open piles cause New Mexico timbers to dry out too rapidly, so that many of them check excessively, and that in this region all timbers should be closely piled. The tests prove that the seasoning of New Mexico timbers is a paying operation.

Other tests were carried on at Las Vegas to determine the best methods for treating New Mexico timbers. These tests show that with the very dry ties obtained in the high altitudes of New Mexico a greater absorption of the preservative follows from treating the timbers without a preliminary steaming. This process has since been followed at the Las Vegas plant. A similar result was obtained from a number of tests made during the months of December and January at the treating plant of the Santa Fe Railroad.

TESTS OF LODGEPOLE PINE AND RED FIR IN THE NORTHWEST.

Many timbers in the Northwestern States require to be treated chemically in order to resist decay. Two years ago experiments were begun to determine the effect on seasoning of cutting timber in the Northwest at different seasons of the year. The tests began near Bozeman, Mont., with the lodgepole pine, a timber hitherto very little used because of its softness and its rapid decay when in contact with the ground. These tests were continued during the present year. One hundred ties of lodgepole pine were cut every month and weighed at monthly intervals. The results show that this timber can be seasoned in five or six months, with a great saving in freight and considerable improvement in quality, compared with unseasoned timber. During the coming year some 2,000 ties will be treated to determine the relation between treatment and the season of cutting.

Attention was called during the past year to the fact that small trees of the lodgepole pine when properly peeled and dried make excellent mine props. Acting upon this suggestion, a number of mine props have been made in Montana and shipped into Wyoming for use in coal

mines, and it is probable that this timber will be increasingly utilized for this purpose. Investigations on a small scale have been carried on to determine the best sizes for this use.

Little is known at the present time as to how to preserve the red or Douglas fir. In cooperation with the Northern Pacific Railroad, tests were begun in March to determine the actual weights of green and dry wood as the first step in a comprehensive study of this tree.

It has already been found that at Pasco, in a semiarid region, ties evaporate water in the first few weeks after cutting nearly six times as rapidly as at Tacoma, in a region of very heavy rainfall. Various forms of piles have been constructed, preliminary figures obtained, and important results are expected.

A series of important treating tests were carried on in cooperation with the Chicago, Burlington and Quincy Railroad, at Sheridan, Wyo., chiefly as to the treatment of lodgepole pine timber with zinc chlorid, with and without preliminary steaming, which appears, so far, to have little effect on penetration. A beginning was also made in testing red fir and western yellow pine from the Black Hills, South Dakota, and this work will be vigorously followed up during the coming year.

A second series of investigations carried on at the Sheridan treating plant dealt with the rapidity with which zinc chlorid leached out from treated ties. The results show that all timbers treated with zinc chlorid should be seasoned until approximately air dry. Recommendations to this effect have been generally followed by those employing this form of preservative treatment.

CENTRAL.

The studies in timber preservation carried on in the Central States were in general aim similar to those already described. In the Mississippi Valley a large number of timbers, especially red, pin, water, and other oaks, beech, red gum, sycamore, etc., are being considered as possibilities for use in many industries, because of the rapid exhaustion of the supply of white oak and hickory. In cooperation with the St. Louis and San Francisco and the Illinois Central railroads a general investigation was begun during the year as to the utility of these timbers for ties and bridge structures. With chemical treatment it was found perfectly practicable to use them both for ties and for other forms of construction, and it is proposed to extend these investigations to strength determinations during the coming year.

A series of tests was inaugurated similar to those carried on in the West to determine the relation between seasoning and the season of cutting. The chief object is to ascertain how to season these woods so that they will not check, split, or warp excessively, and to protect them against excessive rainfall. Approximately 500 ties of as many different timbers as could be obtained were cut each month at various stations, and weighed at regular intervals until they were air dry. A distinction was made between swamp timber and that cut on high ground.

Tests of hill red oak were made at Black Rock and Imboden, Ark., and of bottom red oak and red gum at Portia and Beggs, Ark. In six to eight months the red oaks have lost from 25 to 30 per cent in weight. Ties under roofed piles have shown little tendency to check, split, or warp. Most of the timbers lost the bulk of their moisture in

the first six months. Similar results were obtained in Kentucky, Tennessee, and Mississippi with red oak, beech, and red gum.

In Illinois and Indiana tests to determine the rate of seasoning of white oak ties, which have been in progress almost two years, were brought to a close, and the results are being prepared for publication. The seasoned ties were laid in the track near Brownstown, Ind., and careful record will be kept of their resistance to decay.

Tests conducted in cooperation with the Ayer & Lord Tie Company demonstrated in the case of red oak ties treated with zinc chlorid the importance both of thorough preliminary seasoning and of thorough drying out after treatment, not only in order to increase the effectiveness of the preservative treatment, but also to obviate the loss from splitting due to the freezing of their water content.

EASTERN.

Studies in preservative treatment in the East during the past year were concerned largely with telephone poles, in continuation and enlargement of work begun during the previous year. As a rule, poles are set almost at once after cutting. The poles are of a larger diameter at the butt than is at first necessary to carry the anticipated load of wires and cross-arms, because the diminution in size due to rot at or near the surface of the ground has to be taken into consideration. Should it prove possible to treat poles at the butt economically, very much smaller trees could be used because allowance for weakening by decay would be unnecessary, and the poles could be grown in a shorter time.

The subjects studied were, first, seasoning of telephone poles, and second, treatment of cross-arms. The poles experimented with were of chestnut and white cedar and belonged to the American Telephone and Telegraph Company, in cooperation with whom the work was done. Five stations were maintained, at each of which 50 poles cut each month were carefully weighed and measured, and reweighed and remeasured at monthly intervals to determine the loss of weight and shrinkage.

Preservative tests were carried on at Norfolk, Va., to determine whether it would be possible to treat loblolly pine cross-arms with creosote in such a way that a uniform amount of creosote would be injected into the arm in quantities not over 12 pounds per cubic foot. It was found that under the ordinary method of creosoting, some arms took up but 1½ pounds and others as much as 35 pounds of creosote, resulting in the latter case not only in a waste of material, but also in much damage to property from subsequent dripping of creosote from the arms in hot weather. By omission of the steaming process and a classification of the cross-arms into three groups, it was found possible to bring about a more uniform treatment in less than half the time that had usually been required. The bearing of these tests on the general problem of creosoting is emphasized, for similar results would presumably be obtained with other classes of material.

Cooperative tests of the Rüping process for creosoting was carried on at Perth Amboy, N. J. This process claims to treat timber with creosote at a very small cost. Ties of loblolly, shortleaf, and lodgepole pine, beech, red oak, and red fir were shipped to Perth Amboy.

These tests were not completed. The results have not yet been entirely formulated.

A preliminary investigation, begun in May, 1904, to determine the best methods for seasoning beech, maple, and birch ties, from the Adirondacks, so as to prevent excessive checking and to bring them into a condition fit for treatment, is now under way.

Timber Tests.

During the past year the programme for a series of timber tests was completed. The work thus far accomplished was largely of a preliminary character. Additional laboratories were located, further equipment was purchased, and additional investigations were undertaken. The programme has been submitted for criticism to the American Society of Civil Engineers and the American Society for Testing Materials, and has received their hearty indorsement.

A large volume of data concerning the strength of structural timber in actual market forms and sizes was obtained, which will be useful in economizing the use of timber, perfecting specifications, and establishing rules for inspection. The relative strength of red fir, western hemlock, loblolly pine, and longleaf pine, with characteristic defects, was in part determined. A study of the mechanical properties of red gum wood was made, and its availability for carriage manufacture was established. Studies of the relative strength of tie fastenings, in order to determine the proper form for inferior timbers, have also been made.

An impact testing machine was designed and built, and proper methods of test were developed to determine the brittleness of timber preparatory to a study of the effects of preservative processes on its mechanical properties. The law governing the influence of moisture on the strength of timber was developed with a completeness of detail and scientific precision hitherto unknown. It remains to extend this inquiry to the degree of moisture existing in large timbers, and to ascertain if any increase in strength may be counted on in the case of large sticks as found partially dried on the market. A preliminary examination has been made of the problem of determining the strength of boxboard lumber of various species.

The tests of red fir and western hemlock were made at the timber-testing station of the University of California. The work at the Yale Forest School station included a determination of the effects of moisture and resin on the mechanical properties of timber. This work requires great care in detail.

The tests of loblolly and longleaf pine were made in cooperation with the Bureau of Chemistry, United States Department of Agriculture, at Washington.

The work at the Purdue University station included the study of the mechanical properties of red gum. The relative strength of sapwood and heartwood, both clear and mill-run, the relative strength of mature and immature timber, and the ability of red gum wood to withstand the operations of kiln drying, steaming, and bending which are necessary in the application of the wood to carriage stock, were determined. Other subjects investigated at this station were the pulling strength of the screw-spike as compared with the common spike when driven into railroad ties, a method of test to determine

the brittleness of wood with an impact testing machine developed by the Bureau, and a method for testing the resistance to abrasion of wooden paving blocks.

Expenditures.

The total expenditures during the year under the head of Forest Products were $42,525.20, or 12 per cent of the total appropriation of the Bureau.

Work for the Coming Year.

The seasoning tests in cooperation with the Atchison, Topeka and Santa Fe Railway at Silsbee will be continued, and a number of ties already seasoned at this place will be marked with dating nails and placed in the track, together with unseasoned ties, to determine their relative lengths of life. The piling and treating experiments at Somerville will likewise be continued, and a number of seasoned and green ties will be laid in the tracks of the Southern Pacific Railway and frequently inspected. The seasoning tests with New Mexico timbers will go on in cooperation with the Atchison, Topeka and Santa Fe Railway at Pecos and Rociada, and further treating experiments will be made at Las Vegas.

Treating tests in cooperation with the Chicago, Burlington and Quincy Railway at Sheridan, Wyo., and Bozeman, Mont., will be continued. One of the principal questions to be determined by these experiments is the penetration of preservatives into seasoned wood previously subjected to the steaming process, as compared with the penetration into wood that has not been subjected to steam.

The seasoning experiments already in progress in cooperation with the Northern Pacific Railway at Tacoma and Pasco, Wash., and in cooperation with the St. Louis and San Francisco and Illinois Central railways in Kentucky, Arkansas, Mississippi, and Tennessee will also form part of the work of the year.

Other timber treating and testing work will be conducted in cooperation with the Louisiana Purchase Exposition Company at St. Louis. A complete impregnating plant and several timber-testing machines have been installed on the grounds of the St. Louis Exposition, and a large number of ties, principally of loblolly pine and red oak, will be treated and tested at this station.

Seasoning and treating experiments in cooperation with the American Telephone and Telegraph Company will be continued in New Jersey, Pennsylvania, North Carolina, Maryland, and Virginia, and further experiments will be conducted at Marinette, Wis., and Escanaba, Mich., in cooperation with the Postal Telegraph-Cable Company, the Wisconsin Central Telephone Company, the Wisconsin Central, the Chicago, Milwaukee and St. Paul, and the Chicago and Northwestern railway companies, and with the State of Wisconsin. Particular attention will be paid to the effect which soaking in water exerts upon the rate of seasoning of cedar and tamarack.

Experiments will be made to determine the best method for piling and classifying cross-arms in order to season them in the shortest time. These experimental arms will afterwards be treated at Norfolk, Va. The seasoning experiments on ties made from Adirondack hardwoods

will be continued at Utica, N. Y. These ties will afterwards be treated and laid in the track.

The tests of red fir and western hemlock at the Berkeley laboratory will be continued, and, if possible, another laboratory for their study will be established at Seattle, Wash., in which case work at the Berkeley laboratory will be directed especially to a determination of the mechanical properties of redwood.

At the Purdue laboratory the study of red gum from Missouri and from the Atlantic coast, of the methods of testing wood under impact and abrasion, of the effect of preservatives and preservative processes, of methods of testing paving blocks, and of the strength of boxboards will go on.

The work of the Yale Forest School station will continue along the present lines for a time. The problem of the strength of large timbers and their moisture content will be pursued. Cooperative work in determining the strength of cross-arms for telegraph poles and the effect of the so-called Weed process on the strength of wood will probably be undertaken.

RECORDS.

At the beginning of the fiscal year it became necessary to secure an additional floor of the Atlantic Building for offices. The need of the Bureau for office room increases, not only with the slow increase in the purely office force, but also with the rapid increase in the number of field men who must spend a part of their time in the office preparing reports on their field work. This increase of space during the last year afforded great relief, and it will probably be sufficient for the needs of the Bureau for the next fiscal year (1904–5). Upon the request of the Bureau the owners of the building have erected in the basement a fireproof vault in which may be stored important records, maps, negatives, etc., belonging to the Bureau.

Steps were taken during the past year to reduce the fire hazard. Among them was the installation of a fire-alarm station on the first floor, directly connecting the building with the fire department of the District government. To this an auxiliary station on each floor of the building was connected. Fire extinguishers of approved pattern were installed—16 on the floors occupied by the Bureau and 10 on the floors below.

At the request of the Bureau an inspection of the building was made by the chief engineer of the District of Columbia fire department, accompanied by the chief inspector of the Underwriters' Association, and their report and recommendations were transmitted to the owners of the building. As a result the installation of new fire hose, changes in pumping apparatus, important changes in the electric-light wiring, and other necessary alterations were undertaken by the owners.

Accounts and Supplies.

During the year a radical change was made in the system of accounting for Government property. The system adopted was based on a modification of that in use in the Quartermaster's Department of the United States Army. It included the adoption of a Bureau regulation that every transfer of property between members of the Bureau

must be accompanied by an exchange of an invoice and a receipt, and the record of such exchanges upon a property book by the property clerk. It provided for a form of board of survey to account for property lost or worn out in service, and for a semiannual property return by the property clerk.

No radical departure was made in the purchase of instruments or supplies. Every effort was made to standardize the field instruments and equipment, and this effort has added to their effectiveness and resulted in a considerable saving of money. The requirements of the law and the fiscal regulations of the Department concerning competition have been closely observed whenever practicable.

Files and Filing.

An increase in efficiency and security was effected by several minor changes in the system of filing correspondence in the Bureau. The system as a whole continues to give general satisfaction, and its economy of operation is noteworthy.

Correspondence.

During the year 28,518 official communications were received in the Bureau, and 33,125 sent out.

Stenography and Typewriting.

During the month of January, 1904, all stenographers and typewriters not specially assigned to offices were transferred to this section. In it manuscript is copied and general typewriting is done, and from it stenographers are temporarily detailed when required. The result of this concentration was a noteworthy gain in economy of clerical labor and in uniformity of work. From its inception to the end of the year, 849 items of work were performed, comprising a total of 9,837 typewritten pages, of which 1,413 pages were in tabulated form; 6,888 mimeographed sheets, and a large amount of miscellaneous work. In addition 105 temporary details of stenographers were made for a total of 451 days. The average number of stenographers assigned to this section was 10.

Photograph Laboratory.

During the past year the effectiveness of the photograph laboratory was considerably increased by a rearrangement of the equipment heretofore in use and the installation of new equipment. The new equipment provided for velox or line work, blueprinting by electric light, and for making bromide enlargements and transparencies. The use of electric light was introduced also in making wet-plate negatives for maps. In consequence, the laboratory gained largely in efficiency and in economy of time and labor.

Publications.

There were issued during the year 9 new publications, of which 77,000 copies were printed. The bulletins were as follows: A Working Plan for Forest Lands in Hampton and Beaufort Counties, South

Carolina; The Diminished Flow of the Rock River in Wisconsin and Illinois, and Its Relation to the Surrounding Forests; The Planting of White Pine in New England; and Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers. The circulars were: Forest Fires in the Adirondacks in 1903; Reclamation of Flood-Damaged Lands in the Kansas River Valley by Forest Planting; and Practical Assistance to Users of Forest Products. Two reprints of Yearbook articles were issued: Recent Progress in Timber Preservation; and Relation of Forests to Streamflow. There was also published the Report of the Forester for 1903.

In addition to these publications 8 press bulletins were issued during the year, with a total circulation of 44,000 copies.

Reprints of 10 publications were made to the total number of 39,000 copies.

On June 30, 1904, 11 bulletins and 3 circulars were in the hands of the printer.

The mailing lists of the Bureau are the following: (1) A special list of libraries; (2) a list of representative newspapers; (3) a small foreign list of scientific and governmental institutions; (4) a special list of persons engaged in forest work in the United States; (5) a general list of persons interested in forestry.

The first four lists, which number 3,143 addresses, receive all publications of the Bureau as soon as they are available. To the general list are sent the reports of the Forester, reprints of the contributions from the Bureau of Forestry to the Yearbook of the Department, and circulars of information. Cards are also sent to the general list giving notice of the appearance of bulletins, with brief descriptions of their contents. Applications for bulletins made in response to the card notices are honored in the order of their receipt. The number of addresses on the general list at the end of the year was 9,860.

Expenditures.

The expenditures during the past year in Records, which include instruments, supplies, and rent, amounted to $59,032.08, or 17 per cent of the total appropriation for the Bureau.

The expenditures for Bureau supervision and control in salaries and traveling expenses and for printing amounted to $42,755.65, or 13 per cent of the total appropriation for the Bureau.

REPORT OF THE CHEMIST.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., September 19, 1904.

Sir: I have the honor to submit herewith my report of the operations of the Bureau of Chemistry for the fiscal year ended June 30, 1904, together with an outline of the proposed work for the fiscal year ending June 30, 1905, and an estimate of the probable expenses of the Bureau for the fiscal year ending June 30, 1906.

Respectfully,

H. W. Wiley, *Chemist.*

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

The lines of investigation, indicated in the last annual report, relating to problems connected with the application of chemistry to agriculture were followed with little change during the year ended June 30, 1904. The science of chemistry is connected with scientific agriculture in almost all of its aspects, and thus there is little difficulty in utilizing all the forces at the command of the Bureau of Chemistry in these investigations.

In order to secure economy as well as efficiency in this work the endeavor has been made for many years to collaborate with other scientific investigators in the problems which are under consideration. In this collaboration the Bureau has had the continued help of many of the agricultural experiment stations. This has been particularly true in connection with investigations undertaken to determine the effect of environment upon chemical composition in sugar-producing plants. This work, which was commenced nearly a quarter of a century ago, was confined for a long time to the evolution of a sorghum plant containing a high content of sugar and a low content of melassigenic substances. Later the same lines of investigation were applied to the sugar beet in a general way, and in the last few years these investigations have been specialized in order to determine which one of the factors producing chemical changes in the sugar beet exerts the greatest influence in respect of the content of sugar. During the year the fourth annual series of investigations in this direction was completed. In the study of this problem not only has the Bureau had the helpful aid of the agricultural stations, but also

of the Weather Bureau, which has cordially cooperated by furnishing the meteorological data at or near the various stations at which the experimental work has been conducted.

For lack of funds similar experiments authorized by Congress in the study of the effect of environment upon the composition of the cereal grains have not been pushed as vigorously as desired. Nevertheless numerous comparative determinations have been made of the effect of the environment on the protein content of wheat. These data, which have been collected over a series of several years, have for their chief purpose to indicate the general character of the study necessary to determine more accurately those conditions which affect so seriously the composition of the wheat kernel. The purposes which should be kept in view in the growing of wheat include those particularly relating to the possibilities of panification. A scientific miller desires to produce a grade of flour just as uniform as possible in its composition. Inasmuch, however, as the character of the grain which he purchases varies from year to year and from locality to locality, it has become a necessity to scientific milling to know the general characteristics of the grain in bulk. This having been accomplished, it is possible to so blend grains of different character as to produce the uniform result required. Especially is it necessary for the miller to have at hand grains of wheat with a high content of protein, and particularly in the form which produces during the preliminary process of panification the agglutinating materials known under the common name of "gluten." The studies of the Bureau on this line have added much to our knowledge of those conditions of growth which are favorable to the production of a wheat grain with a high protein, and a correspondingly high gluten content.

While it is generally true in the case of wheat that the gluten content increases *pari passu* with the content of protein, such is not always the case. The causes which disturb the equilibrium existing between the gluten and the protein are worthy of serious and careful study. The ultimate object of the studies which the Bureau has now in hand is to indicate the conditions which are favorable to the production of a grain of any desired quality. It is evident that in this work the well-known principle of selection of seed is of the highest utility, but still more important is it to discover the conditions which will tend to conserve and increase the good qualities which the selected seed is known to possess. This investigation requires not only the constant services of the chemist, but also those of the botanist and the advice and collaboration of the agronomist experienced in the production of cereal grains. The data already collected on this subject are preparing for publication, and will soon be ready to be issued as a preliminary bulletin.

During the past year the demand which has been made upon the Bureau of Chemistry for information in regard to technical problems of a chemical character relating to the production of paper and leather has been very great. The diminishing supplies of raw material in the production of paper and the consequent increase in price have made the agricultural problem of the production of this material one of great importance. Forests suitable for the production of paper pulp are rapidly disappearing, and the deficiency of the material which arises from this cause must be supplied from other agri-

cultural sources. The fibers of many plants which have heretofore been only waste material offer promising sources of supply. Among these may be mentioned the Indian corn stalk, the cotton stalk, and the bagasse, resulting from the manufacture of sugar and sirup from sugar cane. During the year a large amount of work was done in this direction, and, by order of the Secretary, an expert was sent to paper mills to study the practical manufacture of paper pulp from materials of this kind.

The importance of the supply of tanning materials and of the study of leathers in regard to composition, strength, appearance, and durability is also growing, and constant demands are made upon the Bureau of Chemistry for information on these points. The miscellaneous work which has been done in this direction during the year was of such a magnitude as to warrant its organization into some more definite form, and this led to the establishment by the Secretary, on the 1st day of July of the present fiscal year, of a laboratory in the Bureau of Chemistry charged with investigation of problems of a chemical and chemical-technical nature relating to the paper and leather industries.

Most important of the new work which was undertaken during the past year is the inspection of imported food products. Under the act voting supplies to the Department of Agriculture, which took effect on the 1st of July, 1903, the Secretary of Agriculture was authorized to inspect invoices of food products offered for entry into the country and to ascertain whether such foods were adulterated in any particular with substances injurious to health or otherwise; whether they were mislabeled in any respect, either in regard to the character of the goods, of the countries in which they were made, or whether they were of a character forbidden or restricted in sale in the country where they were manufactured, or from which they were exported. The funds which were placed at the disposal of the Bureau for this inspection were limited in amount and were entirely insufficient to provide for a complete inspection, even if such had been desirable at the start. It was therefore decided to confine the inspection to articles which were known to have been, by former inspections, subject to frequent adulteration.

The law provided for collaboration with the Treasury Department, which secured the samples upon request and transmitted them for examination to Washington. The Secretary of the Treasury, also, is the official authorized by the law to exclude invoices from entry after inspection and certification by the Secretary of Agriculture that they fail to comply with the provisions of the law.

Most valuable collaboration was also secured through the State Department by instructions furnished our consuls in foreign ports to require declarations on the part of exporters of food products to the United States regarding the character and origin of the materials offered for export.

The available funds not being sufficient to establish laboratories at the various ports of entry, samples taken at the Atlantic and interior ports were analyzed at Washington. By reason of the great distance from the Pacific ports, however, it was found necessary to establish a laboratory in San Francisco, and this was done in connection with

the laboratories of the agricultural college of the University of California. Experience has shown the great desirability of other laboratories, especially at the port of New York, where by far the greatest number of invoices of food products are liquidated. Fortunately, for the fiscal year 1905 Congress has given a sufficient sum of money to establish a laboratory at New York and to enlarge the one at the Pacific coast. As the work of inspection becomes more thorough it will doubtless be advisable to establish laboratories at other points, especially one at some interior point for the convenience of the interior ports of entry. The character and the amount of work done in the inspection of food products during the year are shown in the following tabular statement:

Statement of imported food samples received by the Bureau of Chemistry and results of inspection reported from July 1, 1903, to July 1, 1904.

Result of inspection.	Wine.	Meat.	Olive oil.	Miscellaneous.	Total.
Admitted with a caution, on the ground of being first offense	50	9	11	38	108
Admitted after the labels were changed to harmonize with the law	1	9	10	17	37
Required to be reshipped beyond the jurisdiction of the United States	37	2	14	3	56
Condemned, but not disposed of	4	11	2	5	22
Total violations of law	92	31	37	63	223
Found to comply with the law	776	150	476	255	1,657
Total number of samples examined from invoices detained	868	181	513	318	1,880
Samples taken from invoices not detained	300	2	3	61	366

The inspection work above outlined has been confined, as is seen, to a very few articles of commerce. The force at our disposal was insufficient to inspect even all the shipments of the particular kinds of merchandise indicated. The result of the inspection, however, is a pointed illustration of the necessity of the supervision which has been exercised. But little attempt was made during the year to consider some of the most important kinds of adulteration which are practiced. These relate especially to the using of false labels, particularly with wines and spirits. In many cases such use of false labels can not be detected by an inspection of any of the physical or chemical qualities of the goods. It can only be determined by some method of securing a certification of the validity of the name employed. This is especially true in the case of classed wines; that is, wines which are entitled to bear the name of a certain locality, vineyard, or chateau. Wines of a similar chemical character may be substituted for these classed wines, and the differences in chemical composition are not sufficient to determine the fraud. In these cases we shall have to rely upon some system of certification such as has been mentioned above. During the year a great deal of attention was given to this subject with the idea of developing for the next fiscal year some system which would be just and efficient.

In a similar manner the use of the term "brandy," as applied to distilled spirits not wholly made, or even made at all, by the distillation of wine, is a fraud of very wide extent. In this case both

the chemical and physical properties, however, may be utilized. There are certain physical and chemical properties which are connected with the distillate of wine which has not been rectified but stored in wood for the purpose of ripening which will enable the chemist to distinguish these products from those of an artificial character. On the other hand, it must be admitted that the expert blender and mixer is able to make a product from alcohol of other origin, coloring matters, oils, ethers, and other aromatic substances which closely imitates in chemical composition the genuine article. During the year this problem was studied both from its chemical and commercial points of view and plans were matured which will be soon placed in operation for the purpose of protecting our trade against spurious articles of this description.

What is said of brandies may be said with almost equal truth of whiskies, and these will be subjected to similar examinations for the purpose of determining whether any fraudulent label has been employed. It is considered that a brandy, in a potable sense, is the total distillate from wine, having an alcoholic content of between 45 and 55 volume per cent, and which has been stored in wooden casks for a period (probably not less than four years) sufficient to oxidize the aldehydes or other components of fusel oils into ethers and other aromatic bodies. The total content of fusel oil should not exceed 0.25 per cent. From a similar point of view a whisky, in a potable sense, is the distillate from fermented cereal grains stored and ripened in the manner just described.

Problems connected with the use of artificial colors, glucoses, and preservatives have also been studied with a view to making the law more efficient. It is held that these bodies should not be used without notification; otherwise they would be considered to be misbranded. Further than this, they must be bodies of a nature not considered deleterious to health, either as determined by actual experiment or in the opinion of the greater weight of expert evidence. When such bodies are by either of these means found to be deleterious to health their presence in minute quantities is considered no excuse. The principles which are enunciated in Circular 15, giving the result of the experiments with borax and boric acid, are held to apply to other bodies of similar character in relation to the execution of the law.

The salutary results which have followed the execution of the law so far are a convincing evidence of its utility and value. While it is not probable that the practice of food adulteration in imported articles can be wholly eliminated, it is quite certain that it may be reduced to minimum proportions and the character of our imported food products be fully assured. Unfortunately, the law does not follow the food products after they are admitted into the country, and subsequent false branding, mixing, or sophistication of any kind must be prevented by the application of the laws of the different States. The extension of the principle of food inspection to interstate commerce would enable the States in the execution of their own laws and with the help of such an inspection to protect their people entirely from the evils of food adulteration.

THE EFFECT OF FOOD PRESERVATIVES ON DIGESTION AND HEALTH.

The work which was begun the preceding year to determine the effect of borax and boric acid on digestion and health was completed, tabulated, and the results prepared for publication. They will appear in detail in Bulletin No. 84. A summary of these results, to be offered for distribution, has been published as Circular No. 15.

The most interesting of the observations which were made during the progress of the experiments was in the study of the direct effect of boric acid and borax, when administered in food, upon the digestion and health. When boric acid, or its equivalent in borax, is taken into the food in small quantities, not exceeding half a gram (7½ grains) a day, no notable effects are immediately produced. The medical symptoms of the cases in long-continued exhibitions of small doses, or in large doses extending over a shorter period, show in many instances a manifest tendency to diminish the appetite and to produce a feeling of fullness and uneasiness in the stomach, which in some cases results in nausea with a very general tendency to a sense of fullness in the head, which is often manifested as a dull and persistent headache. In addition to the uneasiness produced in the region of the stomach there appear in some instances sharp and well-located pains, which, however, are not persistent. Although the depression in the weight of the body and some of the other symptoms produced persist in the after periods, there is a uniform final tendency manifested after the withdrawal of the preservative toward the removal of the unpleasant sensations in the stomach and head, above mentioned.

The administration of boric acid to the amount of 4 or 5 grams per day, or borax equivalent thereto, continued for some time, results in most cases in loss of appetite and inability to perform work of any kind. In many cases the person becomes ill and unfit for duty. Four grams per day may be regarded then as the limit of exhibition beyond which the normal man may not go. The administration of 3 grams per day produced the same symptoms in many cases, although it appeared that a majority of the men under observation were able to take 3 grams a day for a somewhat protracted period and still perform their duties. They commonly felt injurious effects from the dose, however, and it is certain that the normal man could not long continue to receive 3 grams per day.

In many cases the same results, though less marked, followed the administration of borax to the extent of 2 grams, and even of 1 gram, per day, although the illness following the administration of borax and boric acid in those proportions may be explained in some cases by other causes, chiefly grippe.

The administration of borax and boric acid to the extent of one-half gram per day yielded results markedly different from those obtained with larger quantities of the preservatives. This experiment, Series V, conducted as it was for a period of fifty days, was a rather severe test, and it appeared that in some instances a somewhat unfavorable result attended it. On the whole, the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand, it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of boric acid, for a limited period of time without much danger of impairment of health.

It is, of course, not to be denied that both borax and boric acid are recognized as valuable remedies in medicine. There are certain diseases in which these remedies are regularly prescribed, both for internal and external use. The value which they possess in these cases does not seem to have any relation to their use in the healthy organism, except when properly prescribed as prophylactics. The fact that any remedy is useful in disease does not appear to logically warrant its use at any other time.

It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period, or when given in large quantities for a short period, create disturbances of appetite, of digestion, and of health.

During the year the work was prosecuted on the same lines as were followed during the preceding year. The preservatives which were used during the year were salicylic acid, sulphurous acid and sulphites, and benzoic acid and benzoates. Although the experiments were concluded on the 30th of June, the tabulation and study of the data will be a part of the present year's work. No conclusions, therefore, can be given at the present time respecting the results of the investigation.

THE FOOD LABORATORY.

The study of tropical fruits and fruit products has been concluded and the results embodied in a bulletin which is now in press. The study of the composition of fruit with special reference to the changes of composition during ripening and the different methods of storage has been continued in collaboration with the Pomologist. Three varieties of summer apples and three varieties of winter apples were picked at different times during the growing season and their composition determined. Much attention has been given to the study of analytical methods employed in this work and to the study of pectin bodies with a view of determining their nature and establishing methods for their determination. The literature relating to this subject has been carefully reviewed, and a bulletin including this review and the laboratory results on this subject up to date is now in manuscript. At the beginning of the present growing season the work was extended to other varieties of fruits, special attention being given to peaches and bananas, and the study of the ripening of citrus fruits has also been begun.

During the last fiscal year, as heretofore, the Food Laboratory has done important work in studying and comparing methods for the examination of various classes of foods. This work has been in connection with the Association of Official Agricultural Chemists, in which the chief of the Food Laboratory is at present referee on food adulteration. It has also been influenced to some extent by the requirements of the work of the laboratory in connection with the enforcement of the imported-food law. As referee on food adulteration for the Association of Official Agricultural Chemists the chief of the Food Laboratory has worked in collaboration with nineteen prominent food chemists in the United States and Canada, and in addition to this he and his collaborators, each in his special field, have had the cooperation of a much larger body of food chemists. Among the contributions of the Food Laboratory to this subject during the last fiscal year may be mentioned the collaborative work relating to

the Dalican titer test and the study of the methods for the determination of iodin absorption, which were reported to the last meeting of the Association of Official Agricultural Chemists and published in the proceedings of that meeting. Since the meeting of the association this work has been continued on a larger scale than before, and attention has also been given to the Belfield test for the detection of beef stearin in lard. Fifteen samples of lard from hogs that had been fed with varying amounts of cotton seed were also examined to detect the presence of phytosterol.

The study of methods for identifying nitrogenous compounds in meat extracts and other foods was taken up for the Association of Official Agricultural Chemists, and a number of methods that have been suggested for this purpose were carefully compared. A report on this subject was made at the last meeting of the associaton, and after the meeting the work was continued on a somewhat increased scale to secure material for a report which will be presented at the coming meeting.

A method was also worked out for the detection of basic aluminum acetate, which was found as a preservative in imported sausage. This method was published in the Journal of the American Chemical Society.

Considerable attention has also been given, in connection with the Association of Official Agricultural Chemists, to the study of methods for the detection of various chemical preservatives in food. This study is made necessary by controversies that have arisen between manufacturers of food products and those charged with their examination with a view to enforcing food laws. It has been charged in some quarters that these disputes have been due to the unreliability of the methods employed. Again, attention has recently been called to the fact that the natural occurrence in fruits and vegetables of certain chemicals used for the preservation of food is much more widely distributed than was previously supposed, and it has even been claimed that they were sometimes found in fruit in such quantities as might lead to erroneous reports regarding their presence in preserved food. Again, it has even been claimed that some of these compounds were formed in the foods by the methods employed for their sterilization. When we consider the importance of these questions and the extent to which they have been discussed we may naturally expect that some of the claims made will prove to have been exaggerated. At the same time the careful study of all questions involved is important and has been taken up by the Food Laboratory.

In addition to the publications mentioned above there have been published from the Food Laboratory during the last fiscal year a summary of the Federal and State food laws in force in the United States up to July 1, 1902, the full text of the food laws enacted during the winter of 1902–3, a paper relating to the determination of sulphur and phosphorus in food in the Journal of the American Chemical Society, and a paper relating to the methods for the detection of sesame oil in the same journal.

During the entire year a great deal of the time of the chief of the Food Laboratory has been taken up with the exhibit of the Bureau of Chemistry at the Louisiana Purchase Exposition. This exhibit consists of a working laboratory illustrating the nature of the work

of the Bureau of Chemistry. The time required in planning the laboratory, securing the complete equipment, and installing it was considerable, in addition to the time occupied in conducting the laboratory after the beginning of the Exposition.

The enforcement of the law relating to imported foods, which went into effect at the beginning of the last fiscal year, has greatly increased the work of the Food Laboratory. Usually the examinations made were somewhat superficial, being confined to two or three tests on each sample. In a great many instances, however, a much more complete examination was made. Owing to the large number of samples the system of indexing, recording, and reporting in itself required careful and constant attention. In addition to the examinations mentioned, which were for the purpose of deciding whether or not the shipments represented by the samples could be imported into the United States in conformity with the law of March 3, 1903, a complete examination of about 400 samples of imported wine has been undertaken.

By far the greatest amount of the time and energy of the force of the Food Laboratory was occupied with the investigation of the influence of preservatives on nutrition. The fact that the determinations were largely of a routine nature made it possible to systematize the work in such a manner that it could be conducted by a much smaller force than would at first be supposed. At the same time, the great volume of the work in itself presented many serious problems. The work on this subject alone during the fiscal year included more than 15,000 single determinations. Owing to the necessity of calculating the income and outgo of the bodies of the men under experiment a large amount of calculation was necessary after the percentage composition of the various foods was determined. Although this calculation has been greatly simplified by means of regular forms, the development of the latter in connection with the work has required considerable time and attention. After the percentage composition of the food, feces, and urine was determined by the analysts and the results entered on forms prepared for that purpose, there were necessary for the calculation of those results into such form as could be used for comparison something more than 335,000 multiplications of numbers varying from 2 to 4 figures, usually 3 figures each; 40,000 divisions; 17,000 additions, 12,600 of which were columns of about 25 numbers each, and 4,200 subtractions. In this calculation the laboratory has had a very large amount of most valuable assistance from the Bureau of Statistics. Notwithstanding the great volume of work, it has been so systematized that the figures relating to any individual for any day are always accessible and may be referred to instantly without inconvenience.

During the last fiscal year, in addition to the investigation of methods and other comparative studies for which materials in the laboratory were used and special samples were not required, the Food Laboratory examined 1,952 samples secured in the enforcement of the food law, 2,786 samples relating to the hygienic table, and 1,769 miscellaneous samples, making a total of 6,507 samples. At the close of the last fiscal year, owing to the increased amount and importance of its work, the Food Laboratory was converted by the Secretary of Agriculture into the Division of Foods of the Bureau of Chemistry.

ROAD MATERIAL LABORATORY.

During the fiscal year ending June 30, 1904, 228 routine samples were received by the laboratory. Of these, 133 were rock, 35 clay, 15 gravel, 11 brick, 4 floor tile, and 30 miscellaneous material. On these samples the following tests were made: One hundred and six abrasion tests, 154 cementation tests, 51 hardness tests, 35 toughness tests, 12 compression tests, 1 rattler test. Over 100 thin rock sections were cut, 95 petrographical analyses and 37 complete chemical analyses were made, and 10 samples identified. Besides these routine tests, a bulletin entitled "The testing of road materials" has been published and another, on "The cementing value of road materials," has been prepared and is now ready for publication. Among the several investigations pursued during the year probably more time has been devoted to the cementing value of road materials than to any other. The chief results of this investigation are contained in the bulletin just referred to. A number of experiments have been conducted on waterproofing cement and mortar, and also on the tensile strength of clay. This work has not yet been completed, and will be reported on later.

On the 1st of July the Road Material Laboratory was made a division and its name changed to the Division of Tests. The main object of this change was to embrace the testing of all materials of construction relating to agriculture. During the present year it is the intention of this Division not only to make routine tests and investigations of road materials, but to carry on extensive work on the uses of concrete both in road building and its application to farm work. In connection with the experiment stations it is hoped that this Division will be able to render assistance in testing materials used in irrigation work.

A great dearth exists in this country of engineers familiar with the practice of road building. If a school of road building should be established in the Department, which would afford to young men holding degrees in civil engineering at least a year's course in road building, with adequate instruction in the proper use of different road-building materials, the character of rural highways throughout the country would be vastly improved.

There are many other lines of useful work which could be taken up with profit, but the available funds are too small at present to undertake more. I sincerely hope, however, a larger appropriation will be obtained for next year, as the field of work is one which can be made most instructive.

CONTRACTS LABORATORY.

The object of this laboratory is to determine the quality of materials offered under contract to the Department of Agriculture and to such other Departments as may ask for assistance in this direction. It is evident that unless some physical and chemical control be exercised over articles offered under contract the only methods of ascertaining whether the materials offered are of the proper character are those depending upon appearance and general character. Nearly every article which is purchased by the Department of Agriculture and the other Departments of the Government should have certain

physical and chemical properties corresponding to those required in the contract, and it is to determine this correspondence that the aid of this laboratory is invoked.

The work of the past year has been largely the examination of samples of materials submitted with bids for contracts, or furnished upon contracts for the various Executive Departments, and investigations undertaken at the request of the different Executive Departments. In addition to the above, however, some miscellaneous work has been done. The investigation of typewriter ribbons has been started.

The chief of the laboratory is now sugar referee for the Association of Official Agricultural Chemists. This latter work has required considerable attention in the way of preparing pure cane sugar for use in verifying quartz plate values.

The following is a résumé of the work done in this laboratory for the Executive Departments:

DEPARTMENT OF AGRICULTURE.

Early in the year chemical examination and practical tests were made of fire powders for the guidance of this Department, which at that time was considering the advisability of using these powders for fire protection. Practical tests showed that these powders were inefficient in extinguishing fires such as are most likely to occur in laboratory or office buildings.

The investigation of typewriter ribbons has been given considerable attention, with gratifying results; and this work is to be continued, in cooperation with the other Executive Departments, for the purpose of determining the efficiency of the so-called "record ribbons" in producing indelible copies and of outlining specifications for the guidance of this and other Departments in the purchase of these materials.

DEPARTMENT OF COMMERCE AND LABOR.

Five samples of disinfectants furnished with bids for contract and one sample of disinfectant furnished on contract were examined for the Census Office of the Department of Commerce and Labor.

INTERIOR DEPARTMENT.

Two samples of coal furnished with bids for contract of the Government Hospital for the Insane were analyzed for the Department of the Interior.

NAVY DEPARTMENT.

The examination of two samples of linen, to determine whether the material furnished on contract was of the same quality as the sample furnished with the bid, and of four samples of salt-water soap submitted with bids, constitutes the work done for the Navy Department.

POST-OFFICE DEPARTMENT.

The work for the Post-Office Department has been the examination of inks and stamping pads furnished on contract, and of inks, stamping pads, and ingredients used in making stamping pads, submitted

with bids for contracts for the present fiscal year, and the investigation of the relative resistance of the dyes used in making canceling inks for use with rubber stamps, and of the dyes used in printing postage stamps. The awards of contracts for stamping inks, canceling inks, and stamping pads are made upon the basis of results obtained in this laboratory, and these materials, when furnished, are here submitted to chemical and physical tests. The work on the relative resistance of the dyes used in canceling inks for use with rubber stamps has developed the fact that these dyes are generally less resistant to reagents than the dyes used in printing some of the higher denomination stamps, and this has necessitated extreme care in the examination of inks of this class. During the year 62 samples have been examined for the Post-Office Department.

TREASURY DEPARTMENT.

The greater part of the work for this Department has been in connection with the levying of duties. This laboratory has had charge, in collaboration with the Sugar Laboratory, of the comparative sugar tests made in cooperation with the ports of New York, Boston, Philadelphia, and New Orleans. With the exception of 355 sugar samples, the analytical part of this work has been done in the Sugar Laboratory, with the exception of the polariscopic readings. Another important line of work for the Treasury Department has been the examination of soap stocks, machinery oils, and miscellaneous oils, for the purpose of determining whether any of such were for use as alizarin assistants. One hundred and sixty-eight samples were examined in this investigation. Thirteen samples of miscellaneous materials were also examined. These included three samples each of "shoyu" and lead dross, two samples each of listerine, cutch, and "barley-brew base," and one sample of pineapples. At the request of the Director of the Bureau of Engraving and Printing the analysis was made of ten samples of "hard black" and two samples of milori green, regarding which there had arisen a question about the standard of these materials furnished on contract. In all 191 samples, exclusive of sugar samples, were examined for the Treasury Department during the year.

WAR DEPARTMENT.

Eighteen samples of miscellaneous food products for the Commissary Office and one sample each of hay, flour, and forage biscuit were examined for the War Department.

MISCELLANEOUS.

In addition to the above work for the Executive Departments, one sample of fireproofing was examined at the request of the Commissioners of the District of Columbia, and 18 miscellaneous samples were examined in this laboratory. The latter consisted of one sample each of turpentine, vermouth color, paraffin, honey, zinc nails, oxalic acid, and paper, two samples of bagasse, and nine samples of seal and cod-liver oils.

Of the samples reported from this laboratory 26 were examined in other laboratories—three in the Dairy Laboratory, twelve in the Food

Laboratory, eight in the Insecticide and Agricultural Water Laboratory, two in the Sugar Laboratory, and one in the laboratory of the microscopist. Exclusive of sugar samples and samples used in the investigation of typewriter ribbons, 311 samples have been sent to the Contracts Laboratory for analysis, and of this number all but 26 have been examined in this laboratory.

INSECTICIDE AND AGRICULTURAL WATER LABORATORY.

During the past year 38 samples of mineral waters were examined, 19 of which, along with some 40 previous analyses, are to be used in the preparation of a bulletin upon the composition of mineral waters of the United States.

A complete examination of three irrigation waters was made for the office of Irrigation Investigations.

Thirty-eight sanitary examinations of waters were made, 19 of which are to be published in a bulletin. The remaining 19 samples of water were examined either for other Departments of the National Government or for the health officers of small towns where the water supply was suspected to be the cause of disease.

Thirty-two samples of insecticides were examined, some of which were sent in by farmers, but the most of which were analyzed at the request of the Bureau of Entomology. For the Bureau of Plant Industry 8 samples of fungicides were examined, and for the United States Census Office 7 samples of disinfectants.

A determination of the arsenic content of 22 samples of carpet was made. These results, along with some 700 previously obtained, have been incorporated in a bulletin.

Fifty-three samples of chemicals and drugs were examined for the Drug Laboratory as regards their arsenic content.

Eight toxicological examinations were made of samples from the Bureau of Entomology and other sources.

A nearly complete examination has been made of 209 samples of cattle foods and a partial analysis of 106 samples. Twenty-six of these analyses were made for other Bureaus of the United States Department of Agriculture. The remainder are to be reported in a bulletin upon the "Composition of American cattle foods."

The analysis of 13 samples of gases was made by this laboratory for the United States Bureau of Fisheries.

In connection with a study of the injury to vegetation by smelter fumes, undertaken at the request of the United States Department of Justice, some 300 determinations of the sulphur trioxid, moisture, ash, etc., in the water, soil, and foliage of trees surrounding the smelter were made.

Besides the above, 15 miscellaneous examinations were made for the National Government and individuals.

INVESTIGATIONS AND RESULTS.

The chemical examinations of from 65 to 75 prominent mineral waters now sold upon the American market have been completed and the calculations, etc., in connection with the work are now in progress.

A study of the arsenic content of wall papers, furs, fabrics, etc., has been completed and a bulletin reporting the results of the work is

now in press. Since the health of the whole community depends upon healthful surroundings which can not be obtained as long as the air of dwellings is poisoned by volatile arsenical compounds from wall paper and articles of dress contain excessive amounts of this poisonous metalloid, this bulletin is important from a hygienic standpoint. The results of this work may be briefly summarized as follows:

(1) If 0.1 grain per square yard is adopted as the maximum amount of arsenic allowable in wall papers the condition of the market is quite satisfactory.

(2) The arsenic content of glazed shelf and crape papers is as small as could be reasonably expected.

(3) Entirely too large a percentage of the dress goods, stockings, dress furs, and fur rugs sold on the American market contain excessive amounts of arsenic.

(4) The presence of excessive amounts of arsenic in such goods as are described in (3) is dangerous to the health of a large number of people, especially those who are susceptible to arsenic poisoning, and should be prohibited by proper legislation.

The results of our study of the amount of free arsenious oxid in Paris green that can be endured by various classes of fruit trees has been completed and reported in bulletin form. This bulletin is of great value both to practical farmers and to entomologists and chemists who are called upon to judge the value of samples of Paris green to be used in spraying.

At the request of the Department of Justice this laboratory during the past year undertook to prove whether or not certain Government forests in northern California were being killed by the fumes from a copper-smelting plant. The entire time of one chemist for about three months, including two trips to California to collect samples, testify, etc., was necessary before the work was completed.

The results of this investigation, which showed undoubted injury to vegetation by smelter fumes, are nearly ready for press, and will shortly be printed in bulletin form. They will be very valuable to owners of forests and to lawyers who have cases depending on injury from the cause mentioned above.

One of the assistants in this laboratory has been appointed referee on insecticides, fungicides, and disinfectants for the Association of Official Agricultural Chemists, and has during the past year devoted considerable time to comparing and improving the methods of analysis of these classes of compounds.

In addition to the above investigations the chief of this laboratory has completed all analytical work in connection with a method of determining chlorin, bromin, and iodin in mineral waters. The results will soon be published. With the help of one of the assistant chemists the chief of this laboratory is also making an extended study of the chemical composition of the lime-salt-sulphur wash and its probable method of action on scale insects. This laboratory has also during the past year issued an article entitled "Report of the referee on insecticides and fungicides for 1903."

SUGAR LABORATORY.

The work of the Sugar Laboratory during the year included a study of the composition of the juices of a large number of samples of

sugar cane grown upon the experimental plats at Cairo and Waycross, Ga. Samples of sirup made from these canes were also examined chemically.

The samples of sugar beets obtained in collaboration with the agricultural experiment stations in studying the effect of environment upon composition comprised a part of the work.

A systematic study of the composition of maple sugar and maple sirup was undertaken on samples of certified purity secured by the agricultural experiment stations of Vermont, Ohio, and Pennsylvania. These analyses were only partially completed at the end of the year.

The preparation for polarization of all the samples of sugar from the ports of New Orleans, Philadelphia, New York, and Boston formed an important part of the work of the laboratory. One sample from each of these ports is received each working day throughout the year, making altogether during the year 1,216 samples.

The total number of analyses made in the laboratory during the year was over 2,000, which included the miscellaneous examinations of various character relating to the sugar industry.

The vacancy caused by the resignation of Dr. G. L. Spencer, former chief of this laboratory, has not been filled, and the work of the laboratory is conducted under the immediate supervision of the Chief of the Bureau.

DAIRY LABORATORY.

In this laboratory the general work in the investigation of the composition of dairy products is carried on and also, under specific authority of Congress, all the chemical work in connection with the enforcement of the law regulating the manufacture and sale of renovated butter.

During the year ended June 30, 1904, the Dairy Laboratory has examined a total of 320 samples of butter, cheese, and milk, including condensed milk and milk powders or dried milk. Of this number 103 were analyzed or otherwise examined for the Bureau of Animal Industry, in connection with the enforcement of the Federal butter laws; 179 were analyzed in connection with the preservative investigations (hygienic table) of the Bureau of Chemistry; and 38 were from miscellaneous sources.

Because of the diminished amount of help in this laboratory during the past year, due to the long-continued illness of the assistant, the research work that was proposed in the last annual report has not been undertaken, but has been postponed until adequate laboratory assistance shall be secured.

DRUG LABORATORY.

During the fiscal year ended June 30, 1904, 460 samples of material were examined by the Drug Laboratory. Of this number 352 were chemical reagents, 77 crude medicinal plant products, 21 proprietary remedies, 2 materials used for poisoning, and the remaining 8 miscellaneous in character.

The chemical reagents examined were such as were delivered to the Bureau of Chemistry on contract and special purchase. This included not only the highest grade goods, but also many of the ordinary chemicals used for analytical work. The objects of these examinations are:

First, to insure reliable chemicals for analytical work; second, to secure data from which standards of purity can be constructed; and last, to place competitors on an equal footing.

The members of the Association of Official Agricultural Chemists recognized the necessity of securing standards for chemical reagents and directed the appointment of a committee on the testing of chemical reagents, of which the chief of the Drug Laboratory is chairman. The work is well under way and the first report was made at the last regular meeting, September 26, 1904.

Of the crude medicinal plant products 35 were examined for the Bureau of Plant Industry, mostly for the purpose of determining the amount of active medicinal agents present in plants grown and cured under known conditions, to serve as a guide for future work. Others were examined for the presence of certain poisonous agents, said to be present and to have caused the death of many domesticated animals in our Western States.

The remaining crude medicinal plant products in part represented the goods as received at the United States custom-house, being the medicinal herbs supplied to retail druggists. The object of this work is to ascertain to what extent these various products are adulterated, and if free from adulteration and of good quality, the data are to form the nucleus of a basis for standards, the establishment of which now forms part of the cooperative work with the Association of Official Agricultural Chemists.

A few proprietary remedies were examined at the instance of the Post-Office Department and Senator Heyburn, chairman of the Committee on Manufactures. These examinations were made to determine whether these remedies contained any medicinal agents which would warrant the extravagant statements contained in the advertising literature. The results showed that the advertising literature contained many false and misleading statements and that money was in this manner fraudulently obtained. The privilege of the use of mails was withdrawn in every such case.

The Department of Justice submitted two samples of material that were supposed to contain poisonous agents which caused the death of two persons. One contained morphine sulphate and caused the death of a child, and the other was "Rough on Rats," a portion of which is said to have caused the death of one adult.

The miscellaneous samples were examined as to composition and whether the labels were true representations of the contents of the various packages.

MICROCHEMICAL LABORATORY.

The kind of analysis conducted by this laboratory requires that the work shall be largely collaborative with the other branches of the Bureau of Chemistry and with other branches of the Department of Agriculture or the other Departments of the Government desiring such investigations as come within its scope of work.

During the last year the greatest amount of work in any one line has been done in connection with the physiological experiments conducted by the Bureau. This has required the microscopical examination of about 250 urine samples for the following substances: Uric acid crystals; urates; oxalate of lime; phosphates—(*a*) crystalline

phosphates, (*b*) amorphous phosphates; epithelium cells of all kinds; leucocytes; red blood cells; casts—(*a*) hyaline, (*b*) finely granular, (*c*) coarsely granular, (*d*) epithelial, (*e*) other forms; mucous cylindroids; mucous strands.

In connection with these same experiments samples of blood were examined for the estimation of (*a*) the number of red corpuscles, (*b*) the number of white corpuscles, and (*c*) the amount of hemoglobin, requiring in all over 300 analyses.

In collaboration with the Food Laboratory in the enforcement of the imported food inspection law, 30 samples have been examined, such as mustards, chocolates, coffee substitutes, and some fruit products.

Work has been continued during the last year in collaboration with the Food Laboratory and the office of Pomological Investigations of the Bureau of Plant Industry upon the microscopical changes occurring in the ripening of fruits; and in this connection about 65 negatives and photographs have been made.

For certain branches of the Government, especially the Government Printing Office and the Post-Office Department, about 20 samples of paper have been examined to determine the kind of pulp of which they were composed, length of fibers, and the kind of size used. Part of them were also tested for weight, thickness, and opaqueness to light. Work has been begun on a large number of paper-pulp samples recently analyzed by the Bureau, and it is expected that the results will appear, together with the chemical analyses, some time in the near future, in a bulletin upon the subject.

For the Post-Office Department there has been examined a number of samples in connection with the fraudulent use of the mails in offering clothing and certain medicines for sale. The latter class, however, were examined in conjunction with the Drug Laboratory, which made the chemical analyses.

In collaboration with the Insecticide and Agricultural Water Laboratory work has been begun upon a number of samples of cattle feeds, the microscopical work consisting of the identification of the ingredients used in making up the material.

The making of nearly 240 photo-micrographic negatives has taken a considerable amount of time during the past year. The subjects photographed were varied in character, but the larger number were various textile fibers, starches, and a considerable number of crystals of lard and fat products, together with cholesterol and phytosterol mixtures, in connection with work carried on by the Food Laboratory looking to the perfecting of the analytical methods commonly in use. Besides this and some other miscellaneous work, a number of photo-micrographs were made of raphidian crystals and honey glands from various plants for the Bureau of Plant Industry.

The amount of routine work required of the laboratory has prevented during the past year accomplishing much research work. A method has been perfected, however, for the detection of turmeric in mustard, which shows a greater degree of sensitiveness than the tests commonly used.

Material has been collected for a study upon the micro-chemical structure of the sugar beet to determine what relation exists between the cell structure and the sugar content. Samples of wheat being collected in connection with the investigations upon the changes in

composition of given varieties when grown under varying climatic conditions are stored in the laboratory awaiting microscopic examination. The urgency of calls upon the laboratory, however, has required postponement of active work upon both of the above series during the past year, though it is expected that active work will be carried out as soon as possible.

The working out of plans and details in connection with the installing of the exhibit of the Bureau of Chemistry at the Louisiana Purchase Exposition has entailed at times considerable attention from the chief of the laboratory as well as taking up nearly all his time in demonstration in connection with the exhibit during the last part of the fiscal year.

PLANT ANALYSIS LABORATORY.

By the order of the Secretary the Soil and Fertilizer Laboratory was discontinued in the last fiscal year, and in its place was established a Plant Analysis Laboratory. In another section of this report will be found a summary of the work proposed for this new laboratory for the coming fiscal year. This report, in so far as it relates to the work of the Soil and Fertilizer Laboratory, covers only the work previously undertaken and which has been accomplished therein during the year under consideration. The said work may be classed under the following heads:

(1) A continuation of the investigation of typical soils to determine their relative fertility, this being the investigation inaugurated in 1894 under act of Congress.

(2) A continuation of the cooperative study of available plant food in soils with the State experiment stations, as under the authorization of the Secretary, dated January 3, 1902.

(3) A continuation of the investigation as to the acid condition of some soils and the neutralization thereof by the use of lime.

(4) An investigation as to the comparative feeding ability of various crops, upon the same soil, under identical conditions, in pot culture.

(5) An investigation of basic slag, to establish a chemical method for estimating the amount of "available" phosphate for use as a commercial fertilizer.

(6) Miscellaneous work.

In detail the work comprised the following:

(1) A continuation of the investigation of typical soils to determine their relative fertility. This consists of a series of 30-pot culture tests, which has been continued in annual cropping since 1895. Some of these soils are from the Rothamsted station in England and have a crop history of more than fifty years. The data on these soils up to 1903 have been embodied in a bulletin which has been prepared for publication and which will include the entire series of 180 pots, all but 30 being discontinued during that year. The crops for the past year have been analyzed and the results compiled, together with complete field data, such as notes on planting and harvesting, weight of soil used, amount of water added, etc.

(2) Cooperative study of the available plant food in soils. This was the second year of cooperation with some twenty-five State experiment stations in the study of available plant food in soils. The pur-

pose of this has been to establish a relation between pot culture and plot culture, in order that the results of the investigation through eight years of pot culture may be compared to plot study, as the first step toward a practical application of similar data in the science of agriculture.

The method of procedure has been to have the cooperating stations grow a series of plot experiments, and from these plots to take 500 trial samples of soil, which were sent to the Bureau of Chemistry for pot-culture tests, according to the method in use. In addition, laboratory samples from each plot were supplied all stations cooperating or desiring the samples.

During the past year eight plots of 400 square feet each were grown at each station. Four plots were grown in oats, one being treated with phosphate and potash, one with phosphate, one with potash, and one with no fertilizer. Two plots were grown in clover, one being treated with lime, the other not treated. One plot was grown in cowpeas, not treated. One plot was grown in maize, not treated, the maize being sown in rows, as is done for ensilage. The samples of soil that were potted were grown in oats, without treatment.

From each plot a sample of the crop, taken in triangular form, the equivalent of 4 square feet, was cut even with the ground. These samples were forwarded to the Bureau of Chemistry, where they were weighed, subsampled, and analyzed—nitrogen, phosphoric acid, potash, lime, and magnesia being determined.

From the plot study in oats the possible deficiency of potash or phosphoric acid was determined by the fertilization experiments. In the clover plots special studies of the acid condition of the soil were made.

The cowpeas were grown as a type of legume and the maize as a type of cereal. The yield per acre of these various plots was computed as to complete crop, pounds of potash, phosphoric acid, nitrogen, lime, and magnesia. These are compared with the yield of the same soil in pot culture. The results obtained indicate that much care and judgment must be used in taking samples from the field for the purpose of estimating their available food supply for crops. In pot culture the crop has a limited depth to which it can feed, and to estimate by chemical analysis the supply for such conditions is comparatively easy. In plot culture the depth of feeding is indefinite. The greater part of the available supply may be found in the first 6 inches or it may be distributed uniformly even beyond the depth of feeding. It is seen that the taking of the soil samples must be done with reference to the plant which is intended to be grown. Had the work been continued it was the purpose to grow crops representing the various root systems and depths through which the plants feed, provided the subsoil is sufficiently permeable.

(3) Investigations as to the acid condition and remedy in certain soils. This work was prosecuted with much vigor during the past year. Many determinations as to acidity were made in the course of systematic study. Pot-culture experiments were made in which clover was grown as an index to the presence of acid conditions. Thirty-five pots were used for this work. Soils which were known to be very acid were treated with varying quantities of lime, according to the laboratory results as obtained by various proposed methods

for estimating the lime requirements. The results obtained give a practical comparison of the proposed theoretical methods of treatment.

(4) Investigations on the comparative feeding ability of various crops in the same soil. This line of work was inaugurated at the beginning of the past year. Most of the soil investigations that had been undertaken in the laboratory were in conjunction with the culture of oats, this plant having been used in similar investigations perhaps more than any other. The methods of analysis proposed had been based upon the feeding capacity of oats. In order to extend the results of the research to other crops, a scheme was planned for the growing of different crops upon the same weight of the same soil under identical conditions in order to ascertain the plant food supplied to each.

The soil used for this purpose was a superior piece of sod land taken from the Department farm at Arlington. It was put through a quarter-inch mesh sieve and mixed on a sampling floor. The soil was protected from too rapid drying, being worked when it appeared to be in best working condition. It was put through a sampling process and with the greatest care potted in 30 pots in such a way that each contained the same weight of soil, and as far as possible alike in every respect.

These pots were seeded in timothy, clover, vetch, oats (Swedish), wheat, barley, rye, corn, tobacco (White Burley), tobacco (Sumatra), beans (Lima), beans (wax), hemp, cowpeas, beets, buckwheat, potatoes, turnips, cabbage, peas, tomatoes, lettuce, and okra. Duplicate croppings were made in some crops, and one pot was left fallow.

These crops were analyzed and the amounts of the various plant-food elements removed were calculated.

Samples of the soil taken for laboratory study were in process of analysis at the close of the year.

(5) Investigation as to the available phosphoric acid in basic slag. As the laboratory was charged with the investigation of fertilizers, there was inaugurated a study on basic slag. This product is rapidly becoming an important factor as a commercial fertilizer. When methods of fertilizer analysis were defined by the Association of Official Agricultural Chemists this product had not come into the markets. In consequence the standard methods are not suitable for a correct valuation of this substance.

The plan of procedure was to select a soil that was notably deficient in phosphoric acid. The soil was collected near the Maryland Experiment Station. This was prepared for potting as described above, fifteen pots being used for the work, being alike in every detail. Lime, potash, and nitrogen were supplied in all pots excepting two, which were not treated, the same quantities being used in each pot. Two samples of basic slag were used in the experiment, these being secured by putting one sample which was purchased in the market through a sieve of such mesh that it divided the sample into two equal portions, one representing the fine, the other the remaining coarse portion. Varying quantities of these samples were added to the pots, such that the range was from 0 up to 7 grams per pot of the fine and from 0 up to 12 grams of the coarse.

The entire series of pots was seeded in oats. These crops have been analyzed and the amounts of phosphoric acid removed calcu-

lated. From these data it was ascertained at what point the amount of phosphoric acid removed became constant. This represents the minimum amount of slag essential to produce a maximum constant yield.

The amount of phosphoric acid contained in the crop at this point was computed in terms of percentage of the amount of slag supplied that pot, correction being made for the phosphoric acid which may have been supplied from the soil, as indicated by the pots to which everything but slag was added. This percentage was selected as representing the available phosphoric acid in the slag, based on the culture of oats.

A method of chemical analysis was then outlined for obtaining a series of varying results on the slag samples. This consisted in making arbitrary digestion under constant conditions excepting one, the variation of which was to give the variation in the results. The solvent selected was hydrochloric acid, the strength being variable; the digestions were made by boiling 2 grams of slag in 100 cc of solvent for fifteen minutes, the sample being added to the boiling liquid and a reflex condenser used. The results obtained were compared with the results found in the culture experiment. The results of digestion which agreed in the corresponding series were studied minutely. The strengths of solvent were very different, but the filtrates were of the same strength. Accordingly it was assumed that the strength of the solvent should be such that the filtrate of the digestion should have the standard acidity above mentioned. This method of valuation gave the finer sample about 1.8 times as much available phosphoric acid as the coarse.

(6) *Miscellaneous work.*—This comprises work on soils that are sent in for analysis from private parties, that done in conjunction with the sugar-beet investigation, and that in cooperation with the Association of Official Agricultural Chemists on soils and fertilizers, as well as potash, phosphoric acid, and ash analysis.

About 350 crop samples were analyzed during the year in conjunction with a study of the soils which produced them.

EDITORIAL WORK.

The publications and miscellaneous printing of the Bureau for the past year were as follows:

BULLETINS.—Nos. 77, Olive oil and its substitutes; 78, The influence of environment upon the composition of the sugar beet, 1902, including a study of irrigated sections; 79, The testing of road materials, including methods used and results obtained in the road-material laboratory; 80, Adulterated drugs and chemicals; 81, Proceedings of the twentieth annual convention of the Association of Official Agricultural Chemists; 82, Paris green spraying experiments; 83, Foods and Food Control—Legislation during the year ended July 1, 1903; 69, Part VI—Digest and index of food legislation to July 1, 1902; 84, Influence of food preservatives and artificial colors on digestion and health—Part I, Boric acid and borax (in press). Total pages, 1,200.

CIRCULARS.—Nos. 13, Extract from the Proceedings of the Association of Official Agricultural Chemists, 1903; 14, Organization of the Bureau of Chemistry; 15, Results of borax experiments; 16, Officials charged with the enforcement of food laws in the United States and Canada (in press). Total pages, 71.

ARTICLES IN 1903 YEARBOOK.—Determination of effect of preservatives in foods on health and digestion; The adulteration of drugs. Total pages, 20.

Total of original matter printed (pages), 1,291.

REPRINTS.—*Bulletins:* Nos. 46, Methods of analysis (2); 73, Proceedings of the Nineteenth Annual Convention of the Association of Official Agricultural Chemists; 77, Olive oil and its substitutes; 65, Provisional methods of food analysis; 13, Part 9, Cereals and cereal products; 13, Part 10, Preserved meats; 71, Cider making—total pages, 978. *Miscellaneous:* Farmers' Bulletin No. 52, The sugar beet; Circular No. 8, Official method for the analysis of tanning materials (revised); Yearbook articles, (1) Determination of effect of preservatives in foods on health and digestion, and (2) The adulteration of drugs; separate from Proceedings, 1903 (Bulletin 81), Determination of gliadin and glutenin in flour—total pages, 77.

Total pages of reprints, 1,055.

JOB PRINTING.—A total of 192 orders, distributed approximately as follows: Miscellaneous (announcements of Association of Official Agricultural Chemists, circulars, reference forms, index cards, etc.), 49; stationery, 50; circular letters, 16; labels, 18; forms, 19; blueprints, 40.

There is urgent need for an assistant editorial clerk. The material offered for printing by the Bureau of Chemistry is of exceptional difficulty for editing. It is largely tabular in its nature, giving the results of analytical processes, together with the comments upon these results. The enormous quantity of work in connection with the experiments to determine the effect of preservatives and colors upon the health and digestion gives to the editor a task which is entirely too great for one person. We were fortunately able to secure, through the courtesy of the Division of Publications, expert assistance in the special preparation of the bulletin containing the data of the food experiment. Without this assistance the editor's task would have been almost too great to finish within any reasonable time. There is constantly a large amount of material on hand to be prepared for publication. This may be illustrated by the fact that results of researches carried on during a part of the fiscal year ended June 30, 1903, are still unpublished by reason of inability to put the data in proper form. The urgent need of additional assistance in this line is apparent.

CLERICAL WORK.

The clerical work of the Bureau is of such a varied and miscellaneous character that it is practically impossible to give a detailed statement of the amount performed. During the fiscal year ended June 30, 1904, there have been, in round numbers, about 18,000 pages of typewriting done, of which about 12,000 pages were letters. A large amount of miscellaneous typewriting has been done, such as papers for publication in the scientific journals, material for use in the various laboratories, etc., of which no record was kept.

In addition to the above, 1,823 detentions of imported food products have been made out and 1,269 releases of the same.

A large proportion of the clerical work consists of calculating and tabulating the results of the hygienic experiments, making out reports of analyses and tests, keeping up the various card indexes, revision of mailing lists and other work pertaining to sending out of publications, and a multitude of details connected with the accounts of the Bureau, work of such a character that it is impossible to keep even an appropriate record of the quantity done. It needs no argument to show that the clerical force is entirely inadequate in numbers to handle in a proper manner the work necessary to the conduct of the Bureau.

What has been said regarding the character of the editorial work applies with equal force to the work of the clerical force. The mere

work of taking dictation in the answering of letters and writing out the notes is one of the least important parts of the clerical work in this Bureau. In the preparation of manuscript to accompany the results of chemical research the work is of much more difficult character and requires higher skill than that pertaining to ordinary correspondence. The result of all this is that while we are able, as a rule, to keep our letter writing up to date, there is a great deal of work in the preparation of manuscripts for the editorial clerk which is behind. It is found necessary to detail one of the clerical force for service in connection with the new laboratory in the Appraiser's stores at New York. The wants of the Bureau in this line should receive attention in the near future.

SUPPLIES AND ACCOUNTS.

We are in urgent need of more and better situated space for storerooms. At present our supplies are scattered over four floors and two buildings. In addition to the great inconvenience of storing and distributing the supplies when so scattered it is almost impossible for one storekeeper to look after them properly and keep an accurate record of their distribution. The working laboratories are gradually encroaching on the space. The volume of the work of the Bureau is increasing and becoming more diversified, which necessitates both larger quantities and a greater variety of supplies.

A systematic record of the quantity of each item of supplies used is being kept and enables us to estimate very accurately the amount that should be purchased for any given period.

Since the establishment of the Drug Laboratory and the Contracts Laboratory a system for testing apparatus and chemicals has been installed. When a supply of chemicals is received a sample of each kind is submitted to the Drug Laboratory, where it is tested and approved before being accepted. Apparatus before being put in stock is examined in the Contracts Laboratory. This system insures a grade of chemicals and apparatus of the required standard.

Formerly a part of the contingent fund of the Department was available for the purchase of certain items for the use of the Bureau. Under the present arrangement these items are now paid for out of the general fund of the Bureau. The amounts thus expended during the year are given in the following statement:

Furniture	$252.25	Tickets, car	$40.09
Lumber	55.33	Typewriters	402.85
Painters' supplies	44.23		
Stationery	143.47	Total	1,001.20
Soap	63.07		

Following is an itemized statement showing for what purposes the appropriations for the year were expended:

LABORATORY FUND.

Total amount appropriated		$70,300.00
Salaries:		
Statutory roll	$14,800.00	
Miscellaneous roll	34,090.46	
Special agents	1,834.00	
		50,724.46

Rent		$2,800.00	
Requisitions:			
Chemicals	$2,696.98		
Apparatus	4,869.78		
Machinery and hardware	695.81		
Lumber	55.33		
Office supplies and furniture	811.21		
Miscellaneous	538.88		
		9,607.99	
Travel and expense letters:			
Food standards committee	679.79		
Food inspection—			
H. W. Wiley	41.65		
W. D. Bigelow	87.41		
Miscellaneous, H. W. Wiley	141.25		
Drug laboratory, L. F. Kebler	51.77		
Soil and fertilizer, F. P. Veitch	68.37		
Special agent, William Alwood	21.90		
Insecticide and water, B. H. Smith	28.25		
		1,120.39	
Miscellaneous letters:			
Hygienic table	2,440.00		
Enforcing food law—			
Samples	$694.21		
Cablegrams	375.79		
	1,070.00		
Reporting meetings of Association of Official Agricultural Chemists	100.00		
Food samples, W. D. Bigelow	99.92		
Water samples, J. K. Haywood	40.00		
Dairy samples, G. E. Patrick	9.95		
Sugar samples, Arthur Given	24.40		
		3,784.27	
Gas		576.40	
Electricity		171.33	
Telegraph		27.61	
Telephone		25.00	
Express and freight:			
Enforcing food law		454.80	
Miscellaneous		400.00	
Balance		37.75	
			$70,300.00

SIRUP FUND.

Total amount appropriated			$15,000.00
Salaries		$2,652.95	
Contracts:			
Building		1,479.78	
Mill		2,470.00	
Equipment, etc		7,074.64	
Letters:			
Travel and expenses		658.24	
Supplies		609.36	
Freight and express		35.00	
Balance		20.03	
			15,000.00

ROAD MATERIAL LABORATORY FUND.

Amount transferred from road appropriation			$10,000.00
Salaries		$9,443.88	
Requisitions: Apparatus and supplies		396.07	
Letters: Travel and expenses		98.00	
Balance		62.05	
			10,000.00
Receipts from sale of imported food samples not used in analysis for fiscal year ending June 30, 1904			224.64

OUTLINE OF WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1905.

DIVISION OF FOODS.

The work of the Division of Foods will be largely devoted to the experiments on the influence of preservatives on health and to the enforcement of the imported-food law. The former study will occupy the attention of by far the greater part of the force of the Division of Foods for eight months of the year and of a number of the force for the whole year.

Considerable attention must also be given to certain studies of analytical methods for the purpose of enabling us to do more efficient work in the two lines mentioned. Among the methods that must be studied with this in view are those relating to olive oil, vinegar, and the detection of preservatives.

In our past work on the enforcement of the foreign-food law we have found that a large amount of attention was especially demanded by the olive oils brought into this country. In many instances it was noted that oils were imported which contained additions of oils other than olive oil, and had been mixed with a view to being subjected to the analysis ordinarily given to food products. A careful study of all known methods for the examination of olive oil and certain improvements in some of the methods which the Division of Foods was able to make have enabled us to detect forms of adulterations which had previously escaped notice. Our decisions led to several controversies with the manufacturers, and in some cases with commercial chemists, but in every case the first decision of the Department based on these examinations was found to be correct.

Controversies have frequently arisen between some manufacturers of vinegar and officers charged with the enforcement of State laws regarding the purity of certain lots of vinegar. A careful examination into this question has brought the Bureau of Chemistry to the decision that the difficulty was due to the fact that vinegar was made from riper apples than were ordinarily employed, and that for this reason the tests employed which have ordinarily been admitted as standard tests were not applicable. Progress in this study has been made during the past year, and the results obtained up to the present time indicate that we will be able to overcome the difficulty. Considerable time must be devoted to the question, however, before it can be understood from all standpoints.

The question of preservatives is also one that requires much attention. The recent publication of the discovery that salicylic acid is widely distributed in very small amounts throughout the vegetable kingdom, especially in many of the fruits with which it is commonly employed as a preservative, makes it necessary that the amount of salicylic acid which can occur naturally in these fruits be distinctly ascertained in order that a maximum limit for salicylic acid in preserved fruit products may be established. In addition to this it has been claimed during the last few months that certain of the chemicals ordinarily used for the preservation of foods are produced during the process of the canning and sterilizing of the preserved articles. This claim has been publicly made as the result of experimental evi-

dence, although the experiments have not been given in detail. The work must be carefully repeated, as it will necessarily figure in any prosecution based on laws forbidding or regulating the preservation of preserved foods of any kind in hermetically sealed receptacles.

During the early part of the present fiscal year a large number of standard brands of European wines will be examined for the purpose of determining their composition. Considerable attention will be given to the study of methods for the detection of adulterants in foods. This last work will be in collaboration with the Association of Official Agricultural Chemists, for which the chief of the Division of Foods is referee on food adulteration. Some work is also planned for the standards committee of the same association.

The importance of knowing the average chemical constitution of genuine whiskies and brandies, especially in connection with the execution of the law relating to imported food products, is readily recognized. In order that the average character of products of this kind, of American origin, may be ascertained, a request has been made upon the Commissioner of Internal Revenue for 50 samples each of genuine old whisky and brandy and 20 samples each of genuine apple and peach brandy. These samples are taken out of bond under the supervision of an officer of the internal revenue, and are thus guaranteed to be exactly what they are represented to be. A most careful chemical and physical examination, as well as physiological, will be made of these samples in order that a standard of purity may be determined. This work will not only be of value to the officials in charge of the execution of the law relating to imported foods, but will also be of great help to the committee on food standards in formulating proper standards for these products.

A large amount of work will also be done in the Division of Foods during the coming fiscal year in connection with the study of cold storage on the wholesomeness of foods. This work will require a large number of analyses and determinations of heat and nutritive value, as well as direct experiments similar to those conducted on the hygienic table. The actual quantity of work of this kind can not be foreseen, but will depend upon the extent to which we are able to push the investigations in this direction during the fiscal year.

DIVISION OF TESTS.

The usual routine work on the testing of road materials will be carried on as in the past; also several lines of investigation bearing directly on road materials, which in the main will consist in collaborative work on the use of oil and asphaltum for determining the most effective mixtures. Experiments with burnt clays and oil will also be taken up.

Besides the work directly bearing on the testing of road materials, we intend during the coming fiscal year to equip and operate a ceramic laboratory, where clays and other materials used in the ceramic arts may be tested and investigative work carried on. We also propose taking up extensive research work on cements and cement concretes; armored concrete in particular will be investigated, with special reference to its application to agriculture.

CONTRACTS LABORATORY.

It is impossible to foretell just the character of the work which will be required in this laboratory on the request of other Departments of the Government. The collaboration with the other Departments under the authority now existing is rapidly increasing, and it is hoped that Congress will give ample funds to provide for the largest collaboration which the various Departments of the Government may desire. The wisdom of the control so exercised is, it seems to me, undoubted.

During the present year the investigation of canceling inks for the Post-Office Department has been given much attention, and this work should be continued next year, as there is still much to be accomplished in that line. The investigation of typewriter ribbons has been taken up, and results thus far obtained will warrant a more thorough investigation of the subject at an early date. In this connection it seems advisable that the question of record writing inks for use in the various Executive Departments should receive attention as soon as opportunity permits.

The necessity of some control of the chemical glassware furnished to this Department is obvious, and a large amount of work should be done before the specifications are made out for next year to determine the wearing qualities and adaptability to chemical work of the more common glassware.

In addition, therefore, to the routine work of this laboratory, the investigation of canceling inks and of typewriter ribbons should be continued and the examination of writing fluids and of chemical glassware should be taken up during the present year.

INSECTICIDE AND AGRICULTURAL WATER LABORATORY.

This laboratory, in addition to its functions as indicated by its name, has collected during the last two months a representative lot of about 300 cattle foods sold on the American market. The composition of these will be studied during the present year with the especial idea in view of detecting adulterants and improving our knowledge of those compounds now grouped as nitrogen-free extract.

A bulletin on American mineral waters, which has occupied the time of one chemist for nearly a year, will, it is expected, be completed some time during the present year.

Our collaboration with the Bureau of Entomology, which is constantly increasing, will very likely occupy a large part of the time of one of the chemists in this laboratory.

At the request of the office of Irrigation Investigations a study of a large number of irrigation waters from all parts of the rice region of Texas and Louisiana, and from other southern and western regions, will be undertaken.

If time permits, our studies of the effect of soluble arsenical insecticides upon the foliage of various varieties of common fruit trees will be continued.

We will continue to study the composition of new insecticides as they come upon the market and will extend our work so as to cover disinfectants and like preparations.

Since beverages are now included authoritatively under "foods," the examination of waters becomes a part of the regular food work. Imported mineral waters, therefore, will be subjected to inspection the same as other food products, and the work of this inspection, in so far as its chemical character is concerned, will be given to the Water Laboratory. It is advisable, therefore, that the work of the laboratory be extended, in harmony with the suggestions in regard to estimates which are made further along. Efforts are making, moreover, to collaborate with the Hydrographic Division of the Geological Survey in collection of samples of water directly from their sources in order that there may be no mistake in regard to the character of the water as it comes from the springs and before it is possible that it should have received any chemical treatment. These waters will not only be those of a potable character, but also those which it is proposed to use in the irrigation work.

SUGAR LABORATORY.

The work of the Sugar Laboratory during the present year will be directed, with the collaboration of the agricultural experiment stations, to the examination of sugar beets, with reference to the effect of environment on their composition.

Polarizations in the collaborative work with the Treasury Department will be continued in this laboratory.

The examination of certified samples of pure maple sugar and sirup will be continued and completed in order to form a basis of fixing a standard for such products. The chemical work in connection with the experiments in the manufacture of pure table sirup will be done in this laboratory.

In general, the work will be directed to the investigations above mentioned and also to the further investigations of starch in sugar-producing plants as affected by environment. It is hoped that the study of sweet potatoes as a possible source of starch, glucose, and alcohol may soon be taken up in this laboratory.

DAIRY LABORATORY.

The lines of research which at present seem the most important for this laboratory to take up, either alone or in collaboration with the Bureau of Animal Industry, are the following:

(1) A study of the butters produced in the South by heavy feeding of cotton-seed products, since butters so produced bear strong resemblance to adulterated butters.

(2) A study of the condensed milks and milk powders or dried milks manufactured in the United States, and the methods of their manufacture.

(3) Examination of methods proposed for the rapid estimation of the amount of water in butters, methods of possible usefulness at creameries and renovating factories in controlling the water content of the output.

(4) Examination of methods proposed for the detection of moderate or slight adulteration of butters. One of the most pressing needs

of dairy laboratories the world over is a reliable method for detecting such adulteration.

It is hoped that provision can be made for at least making a start upon some of these lines of research during the present year. To make such a start in a creditable manner, and at the same time to carry on the regular work of the laboratory—consisting of the analysis of renovated and other butters for the Bureau of Animal Industry in its work of enforcing the law, the analysis of all dairy foods used at the hygienic table in the food and preservative investigations of the Bureau of Chemistry, and any work required by other branches of the Government, by State institutions, by the Association of Official Agricultural Chemists, or by individuals when the work promises public benefit—will require a laboratory force of four persons—the chief of the laboratory and three assistants.

DRUG LABORATORY.

The investigation of chemical reagents begun in this laboratory, and for which a special committee was appointed last November by the Association of Official Agricultural Chemists, will be continued during the present fiscal year. The publication of a bulletin containing the very interesting results obtained in the examination of chemical reagents by this laboratory will soon be made. The cooperative work of the referee on medicinal plants and drugs at present in progress by the Association of Official Agricultural Chemists is to be prosecuted with vigor. A bulletin will be published embodying the investigations of crude medicinal drugs by this laboratory and the methods employed in this work.

During the past year this laboratory has made 30 analyses of the so-called "medical nostrums" for the Post-Office Department, which is making an effort to weed out some of these obnoxious products by denying the manufacturers of them the use of the United States mails. The analysis of these medicinal products is a new field and involves the necessity of devising methods of analysis. This collaborative work with the Post-Office Department is one of great usefulness, and its continuation will be the means of protecting the public from many misstatements and deceptions.

During the past year the Drug Laboratory made 33 analyses of plants for the Bureau of Plant Industry, 2 for the Department of Justice, and 1 for the Division of Entomology. At least the same amount of work can be expected from these departments during the next year.

The next revision of the United States Pharmacopœia will probably become effective January 1, 1905. This book is the standard of numerous medicinal remedies recognized by most of the State laws, and an investigation along the lines laid down by this volume is contemplated.

Arrangements have been made for the purpose of studying the quality of the various cod-liver oils on the market to determine in what manner the American oil differs from the European, what the causes of these differences are, how they may be eliminated, and to establish a standard for genuine cod-liver oil.

MICROCHEMICAL LABORATORY.

During the present fiscal year the work of this laboratory will be continued on the same general lines as during the past year. Special attention will be given to the micro-chemical study of cereal grains as affected by different environments. The distribution of the starch and protein cells, it is known, is profoundly changed by the different environments in which the grains are grown. The extent and character of these changes will be made a special study.

This laboratory will also assist the Leather and Paper Laboratory in the examination of fibers and in the micro-chemical testing of the same in order to determine their origin.

In connection with the Drug Laboratory work will be prosecuted in the determination of minute quantities of active principles in drugs which are so small as to escape the ordinary methods of determination. This work will consist in the study of their color reactions and crystalline characters.

In general, all micro-chemical work pertaining to any of the divisions or laboratories of the Bureau will be conducted in this laboratory.

PLANT ANALYSIS LABORATORY.

The purposes of this laboratory are the study of the composition of plants and, to a limited extent, of fertilizers. The work will be materially different from that of the Soil and Fertilizer Laboratory.

The laboratory has concluded and presented for publication the results of an eight years' experiment on a study of the condition of available plant food in soils and in pot culture.

As a supplement to the work of the Soil and Fertilizer Laboratory it is the purpose to investigate the composition of economic plants with reference to the plant food contained as an index to the drain upon the soil and means for reducing this drain through a return of the waste products to the soil.

In conjunction with this work it will prove desirable to collaborate with the other Divisions and Bureaus of the Department, especially the Bureau of Plant Industry, in the chemical study of plants. The laboratory will conduct such investigations as may be desired in this direction.

Some of the investigations in which collaboration is contemplated for this year are as follows, the scope and plan being dependent upon the investigations in the Bureau of Plant Industry: Investigation of cereals with reference to the chemistry of their milling, and other properties; investigations of canaigre and other tannin-bearing plants; study of the composition of alkali-resisting cereals; study of the composition of the cotton plant with reference to the effect of environment upon its oil content; in fruit investigations, the chemical examination of the products and changes, with reference to the nutritive chemical and digestive properties; the composition of grasses, forage crops, and other animal foods, as related to their food value; the investigation of hemp as to its chemical composition, with reference to the plant food removed and the conservation of the same in the waste products; methods of retting, the chemistry of the process, and its products.

In addition to the above, the laboratory will conduct pot-culture

experiments on the use of basic slag, with reference to the establishment of a method for determining the value of this product as a commercial fertilizer; an investigation of the composition of the tobacco plant, with especial reference to the heavy drain this crop makes upon the plant food, and methods for replacing this loss through the waste products of the crop as far as possible.

LEATHER AND PAPER LABORATORY.

SCOPE OF THE WORK.

It is proposed to include in the work of this laboratory chemical investigations and analysis of the raw materials and products of tanning, of paper making, and of wood products which are themselves chemical products or the result of chemical processes. This would cover chemical work on tanning materials, leathers, the waste products of tanning, paper-making materials, papers, chemicals and wastes, turpentine, rosin, and the products of the destructive distillation of wood.

GENERAL LINES OF WORK.

It is perhaps a little remarkable that in this country we have no Government research institutions nor testing laboratories devoted to the leather, paper, or turpentine industries. In this the United States is behind the nations of Europe, and with decreasing raw materials there is need of such laboratories. As the raw materials used in these industries are chiefly agricultural products of national importance, it is highly fitting that such work should be done by the Department of Agriculture, and as the foundation processes involved are purely chemical, the work belongs to the Bureau of Chemistry.

TANNING AND LEATHER.—The leather trades, having an invested capital of approximately $350,000,000, constitute one of the largest industries of the country, and yet we have but little insight into the nature of the various processes and reactions which take place in the making of leather, or of the points at which serious losses do and may occur. The value of the various tanning materials as to the quality and quantity of leather produced is known only in a very general way. Our domestic tanning materials are being used up at a rapid rate, and we are now importing large quantities, a considerable amount of which could be produced at home by the improvement and utilization of some little-known domestic materials.

An examination of the tanning value of the more promising of these materials, such as the western hemlock or the western tanbark oak, both of which contain considerably more tannin than eastern barks, would yield results of immediate practical value, while a thorough examination of the leather produced by various tannages would extend and broaden the work thus started. The losses of weight during manufacture are often a serious matter in the production of leather, and the determination of their nature and the conditions producing them, with methods of prevention, would add thousands of dollars to the value of the products.

The oils used in currying range in price from 22 cents per gallon for menhaden oil to 40 cents per gallon for cod oils, and are so adul-

terated that detection is very difficult; while the causes for the widely different currying powers of these oils is known only in a general way, though that there is a marked difference in their value is well recognized in the finished product.

The quantity of certain tanning extracts imported is steadily increasing, and, owing to the fact that these extracts so closely resemble the tannin-containing extracts which are used in dyeing and come in duty free, there seems to be some effort to import the first mentioned under the name of of the latter extract. Effort should be made to develop tests which will enable us to differentiate with certainty between these substances.

PAPER.—Our well-known pulp woods are being used up faster than they are growing, and as a consequence the demand for new materials has led to efforts to utilize many waste products, among which bagasse, cornstalks, Southern pine refuse, rice straw, and hemp stalks all present exceedingly promising fields for investigations for the purpose.

TURPENTINE.—The continued rise in the price of turpentine, due to the constantly widening field of use and the constantly decreasing supply, has led to two things, viz, the adulteration of the regular article and the recovery by distillation of that contained in the dead trees, sawdust, stumps, and other refuse.

The detection of adulterants is a very difficult problem, as no reliable methods are yet known that enable us to detect with certainty small additions of even the more common adulterants, and investigation along this line is very desirable.

The processes of distillation, both of ordinary spirits and particularly of that from dead wood, are far from economical and are productive of spirits of not the highest grade. The value of the product could be materially increased by a careful investigation of the processes of distillation.

PROPOSED WORK FOR THE PRESENT YEAR.

The following is the proposed scheme of work for the present fiscal year given in detail:

(1) Study of the extraction of tannin from tanning materials, with a view to reducing materially the large losses in this process. From one-eighth to one-third of the tannin contained in bark and other tanning materials is now lost annually.

(2) Study of quick-growing or hitherto but little used tanning materials for the purpose of determining their leather-making value and also their susceptibility to improvement with a view to supplementing our rapidly decreasing materials now generally used.

(3) Investigation and valuation of *degras*, or wool grease, and of methods for the detection of its adulterants.

(4) Investigation of the physical and chemical qualities of various leathers.

(5) Investigation of the chemical and physical properties of the more important kinds of papers and from this and other data the preparation of standard specifications for papers designed for various uses.

(6) Investigation of new raw materials for pulp and paper making and demonstration of the value of such materials.

(7) Investigations of the distillation of turpentine, with particular reference to improving the yield and quality of the product from waste pine.

(8) Investigation of the adulteration of turpentine.

(9) Investigation of the destructive distillation of wood.

The laboratory will hold itself in readiness to cooperate, so far as its facilities will permit, with the other bureaus and divisions of this and other Departments in work which comes within its province.

On many of the subjects outlined above nothing more than the preliminary work can be undertaken this year. Indeed, some of them are so wide in their scope that they will furnish work for several years, and to handle them properly will require additional force, equipment, and supplies.

ESTIMATES FOR THE FISCAL YEAR ENDING JUNE 30, 1906.

I submit herewith the estimates for this Bureau for the year ending June 30, 1906. I call attention first to the fact that I have recommended that there be transferred to the statutory roll a number of chiefs of divisions and laboratories who are now paid from the general fund. This apparently makes considerable increase in the statutory roll, but it is only a transfer from one fund to another. The only increases recommended in the statutory roll are of $1,000 for the salary of the Chief of the Bureau, $1,080 for custodian of records and files, and $1,400 for an editorial clerk. The manifold duties of the Chief of the Bureau and his relations, as chief, to all the Departments of the Government, and his duties in execution of the laws relating to foods, seem to warrant without question the increase in his compensation. The necessity for the editorial clerk has been fully set forth in the body of the report. There is also urgent need of a custodian of records and files.

In order that an idea may be had of the way in which the money asked for is to be expended, the amount for general expenses has been itemized. The amounts asked for are practically the same as the present year, except for the three new laboratories which have just been established. For these special estimates amounting in all to $19,000 have been made. The amount for supplies, apparatus, etc., is based on the expenditure of the past year, namely, $12,000. The total amount for general expenses is thus brought up by the $19,000 estimate for new laboratories to $96,000.

In the execution of the law relating to imported food products there is first given an itemized statement of the expenditures at the present time of the $30,000 available for this purpose. I submit an additional estimate of $16,000 for the establishment of four additional laboratories of inspection, namely, at Boston, Philadelphia, New Orleans, and Chicago, making the total amount required for inspection of imported food products $46,000.

I submit also special estimates for work, part of which has been authorized by Congress, namely, the investigation of the effect of cold storage upon the wholesomeness of foods, for which Congress

gave no special appropriation. It will require at least $15,000 to carry out properly the wishes of Congress in this particular.

I submit also an estimate of $15,000 for an investigation of the sweet potato and yam with reference to their suitability for the manufacture of starch, glucose, and alcohol. This is an investigation which has been asked for repeatedly by the agricultural interests of the Southern States. During the present year we will complete the investigation of the problem of the manufacture of table sirups from sugar cane, for which Congress the present year has given $15,000. I recommend, therefore, a similar amount to be devoted to the study of the sweet potato for the purposes above mentioned.

The increased estimates as submitted for the Bureau amount to $48,080. I beg to call especial attention to the fact that these estimates have been made on a basis of actual work which can be done to the great benefit of agricultural science. No item has been given at a larger figure than is necessary with the idea that it will be cut down to a lower sum. I suggest, therefore, that the sums mentioned be asked for without decrease. While the items have been given for the information of those interested, it is suggested that the bill be prepared in substantially the same form as the present law, with one general appropriation for the Bureau, modifying the language to suit the new work provided for and omitting those portions relating to work already accomplished.

REPORT OF THE CHIEF OF THE BUREAU OF SOILS.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 16, 1904.

SIR: I have the honor to transmit herewith a report upon the work of the Bureau of Soils for the fiscal year ended June 30, 1904.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

PROGRESS OF THE SOIL SURVEY.

The area surveyed and mapped during the fiscal year was 29,058 square miles, or 18,597,120 acres. The area surveyed during the preceding fiscal year was 23,293 square miles, which, together with the work done prior to that time, makes a total area surveyed up to that date of 74,795 square miles, or 47,868,800 acres.

The work was carried on during the past year in 68 areas in 33 States. On an average 20 parties have been working continuously throughout the year, in the Southern States during the fall and winter and in the Northern States during the spring and summer months.

The areas surveyed and the cost of the work in each area are shown in the following tables:

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported.

State or Territory.	Work during 1904.	Work previously reported.	Total area.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	2,396	1,223	3,619	2,316,160
Arizona	.....	611	611	391,040
Arkansas	626	251	877	561,280
California	1,679	3,921	5,600	3,584,000
Colorado	228	1,345	1,573	1,006,720
Connecticut	.....	518	518	331,520
Delaware	314	.....	314	200,960
Florida	185	518	1,033	661,120
Georgia	853	757	1,610	1,030,400
Idaho	58	1,077	1,135	726,400
Illinois	2,333	3,592	5,925	3,792,000
Indiana	889	387	1,276	816,640
Iowa	1,287	1,016	2,303	1,473,920

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported—Continued.

State or Territory.	Work during 1904.	Work previously reported.	Total area.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Kansas	999	404	1,403	936,320
Kentucky	.....	837	837	535,680
Louisiana	1,446	942	2,388	1,528,320
Maryland	29	2,634	2,663	1,704,320
Massachusetts	386	410	796	509,440
Michigan	517	858	1,375	880,000
Minnesota	.....	233	233	149,120
Mississippi	1,352	1,317	2,669	1,708,160
Missouri	1,111	919	2,030	1,299,200
Montana	.....	107	107	68,480
Nebraska	1,195	.....	1,195	764,800
New Jersey	.....	1,303	1,303	833,920
New Mexico	.....	129	129	82,560
New York	986	1,558	2,544	1,628,160
North Carolina	687	4,646	5,333	3,413,120
North Dakota	386	856	1,242	794,880
Ohio	1,409	1,355	2,755	1,763,200
Oregon	60	386	446	285,440
Pennsylvania	.....	1,204	1,204	770,560
Porto Rico	.....	330	330	211,200
Rhode Island	500	.....	500	320,000
South Carolina	1,159	2,032	3,191	2,042,240
South Dakota	.....	485	485	310,400
Tennessee	1,596	547	2,143	1,371,520
Texas	2,564	1,733	4,297	2,750,080
Utah	306	994	1,300	832,000
Vermont	227	.....	227	145,280
Virginia	656	2,747	3,403	2,177,920
Washington	.....	510	510	326,400
West Virginia	39	.....	39	24,960
Wisconsin	.....	955	955	611,200
Wyoming	309	.....	309	197,760
Total	29,058	45,737	74,795	47,868,800

Areas surveyed and mapped, and cost of field work, during fiscal year ended June 30, 1904.[a]

State or Territory.	District.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Alabama	Fort Payne	509	$1.68	$856.50
Do	Huntsville	506	1.70	862.53
Do	Macon County	621	1.60	995.20
Do	Sumter County (survey in progress)	760	2.75	2,090.00
Arkansas	Miller County	626	2.12	1,328.53
California	Bakersfield	196	9.86	1,932.48
Do	Sacramento (survey in progress)	710	3.99	2,833.15
Do	San Bernardino	700	2.71	1,897.00
Do	San Jose	73	4.73	*b* 345.00
Colorado	San Luis Valley	228	3.20	*b* 730.58
Delaware	Dover	314	1.59	497.70
Florida	Gainesville	485	1.75	850.00
Georgia	Bainbridge	364	2.74	996.45
Do	Dodge County	489	1.98	968.59
Idaho	Blackfoot	58	2.80	*b* 162.30
Illinois	Johnson County	339	1.75	*c* 594.87
Do	Knox County	237	1.79	*b c* 425.25
Do	McLean County	1,159	1.44	*c* 1,667.95
Do	O'Fallon[d]	72	1.10	79.20
Do	Winnebago County	526	2.72	*c* 1,431.46
Indiana	Boonville	264	1.77	467.10
Do	Madison County	435	1.23	535.50
Do	Scott County	190	2.03	385.70
Iowa	Cerro Gordo County	567	1.55	881.28
Do	Tama County	720	1.26	910.49

[a] This includes the salaries of the men while in the area and their subsistence expenses, but not the cost of transportation to and from the area.
[b] The portions of these areas surveyed in the preceding fiscal year were given in the last report.
[c] Of these amounts, $2,307.57 was paid by the Illinois experiment station.
[d] This area comprises parts of Illinois and Missouri.

Areas surveyed and mapped, and cost of field work, during fiscal year ended June 30, 1904—Continued.

State or Territory.	District.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Kansas	Garden	331	$2.06	$681.86
Do	Parsons	398	1.52	606.76
Do	Russell	270	2.65	715.50
Louisiana	Acadia Parish	636	1.69	1,075.20
Do	De Soto Parish (survey in progress)	500	3.47	1,735.00
Do	New Orleans	310	1.89	[a] 584.60
Maryland	Leesburg [b]	29	2.39	69.69
Massachusetts	Connecticut Valley	386	1.95	[a] 754.63
Michigan	Pontiac	277	3.47	[a] 961.38
Do	Saginaw (survey in progress)	240	2.35	564.00
Mississippi	Biloxi	615	2.77	1,704.00
Do	Jackson	737	1.25	921.60
Missouri	O'Fallon [c]	600	1.10	660.00
Do	Shelby County	511	1.88	960.68
Nebraska	Grand Island	446	1.96	875.07
Do	Kearney (survey in progress)	426	2.15	915.90
Do	Stanton	323	1.89	609.12
New York	Auburn (survey in progress)	125	5.12	640.00
Do	Long Island	285	1.16	330.00
Do	Syracuse	416	1.96	816.00
Do	Vergennes [d]	160	2.33	372.80
North Carolina	Asheville	497	3.06	1,522.50
Do	Craven	.....	.....	664.30
Do	Saluda	190	2.54	482.60
North Dakota	Jamestown	386	2.31	[a e] 890.44
Ohio	Ashtabula	340	1.75	593.45
Do	Coshocton County	560	1.36	761.60
Do	Wooster	500	2.03	1,015.00
Oregon	Baker City	60	5.29	[a] 317.44
Rhode Island	State (survey in progress)	500	1.53	765.00
South Carolina	Charleston	400	2.86	1,144.05
Do	Lancaster (survey in progress)	50	2.27	113.50
Do	Orangeburg	709	3.21	2,274.30
Tennessee	Davidson County	501	1.56	780.00
Do	Greenville	655	1.28	838.40
Do	Pikeville	440	1.78	782.34
Texas	Anderson County (survey in progress)	827	2.15	1,778.05
Do	Austin	705	1.29	910.98
Do	Paris	548	2.18	1,193.50
Do	San Antonio	484	2.17	1,051.92
Utah	Bear River Valley (survey in progress)	133	6.33	841.89
Do	Provo	173	4.60	[a] 795.24
Vermont	Vergennes [d]	227	2.33	527.20
Virginia	Leesburg [b]	351	2.39	837.69
Do	York Neck (survey in progress)	305	3.00	915.00
West Virginia	Leesburg [b]	39	2.39	93.92
Wyoming	Laramie	309	3.46	1,069.50
Total		29,058	2.21	64,238.36

[a] The portions of these areas surveyed in the preceding fiscal year were given in the last report.
[b] This area comprises parts of Maryland, Virginia, and West Virginia.
[c] This area comprises parts of Illinois and Missouri.
[d] This area comprises parts of New York and Vermont.
[e] Of this amount, $70 was paid by the geological and agricultural survey of North Dakota.

RECAPITULATION.

Cost of field work	$64,238.36
Supplies	1,464.18
Traveling expenses between areas	4,115.55
Other expenses	2,783.32
Total cost of soil survey	72,601.41
Paid by State organizations	2,377.57
Paid by Department of Agriculture	70,223.84
Area surveyed ..... square miles	29,058
Cost of work in field per square mile	$2.21
Transportation, supplies, and other expenses, per square mile	.29
Average total cost per square mile	2.50
Average cost to Department of Agriculture per square mile	2.42

The cost of the work in the field has increased from $2.19 per square mile, reported last year, to $2.21 per square mile during the year just closed, while the average cost of the work to the Department of Agriculture, including all transportation, supplies, and office expenses, has decreased from $2.63 per square mile, reported last year, to $2.42 per square mile during the year just ended.

There has been a continued demand for this soil-survey work, and there are on file demands for about two years' work yet unfilled, while requests continue to come in which can not be immediately considered.

There has been a steady demand from colleges, experiment stations, and private enterprises for men trained in this soil-survey work, and during the past year several men have left the Bureau to accept more lucrative positions elsewhere. As the Bureau now has about 40 men who have been trained in this work, a limited number of such cases

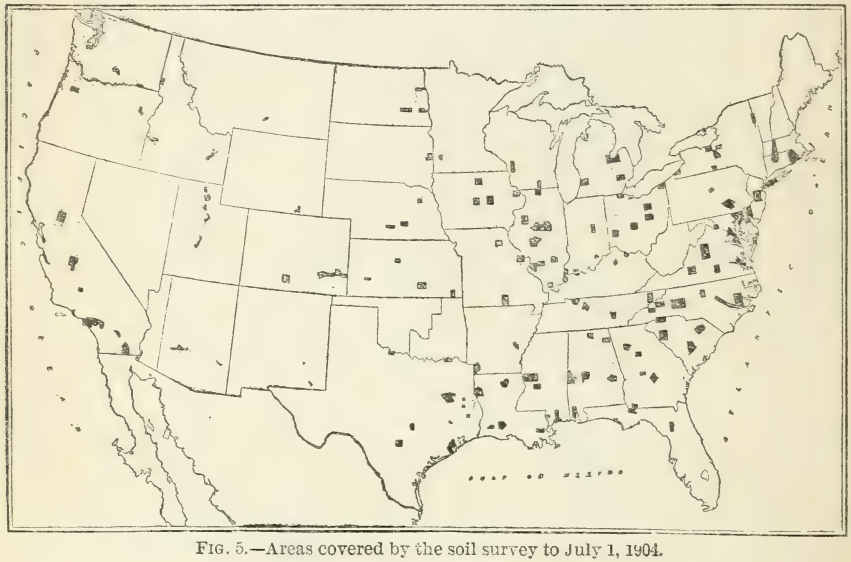


FIG. 5.—Areas covered by the soil survey to July 1, 1904.

can be met without serious inconvenience to the work of the Bureau, even if Congress should provide for a considerable increase in the work.

BRIEF SUMMARY OF THE RESULTS OF THE SOIL SURVEY.

The following gives, very briefly, the results of the work in the following areas:

ALABAMA.

Three areas were completed and a fourth, Sumter County, was in progress at the close of the fiscal year.

The Fort Payne area (509 square miles) is relatively in an undeveloped state. Cotton is the principal money crop. At least 90 per cent of the area is better adapted to fruit growing and late truck farming than to general farm crops, the soils being sandy or stony loams.

The Huntsville area (506 square miles) contains some of the fertile Hagerstown loam soils, covering over 50 per cent of the area, recog-

nized in Pennsylvania and the valley of Virginia as the finest types for general farm crops and for fruit, while much of the remainder of the area is adapted to fruit growing. Cotton is at present the chief crop, but with improved methods and diversification of crops this should become a most flourishing agricultural district.

Macon County (621 square miles), in the south-central part of the State, contains over 40 per cent of its area soils identical with those on which experiments are now being made in other parts of the State for the production of the Cuban type of filler tobacco. About 30 per cent of the area is adapted to truck crops. At present cotton is the important crop of the area, but the opportunity exists for greater diversification and the introduction of new and important agricultural interests.

These, together with the areas heretofore surveyed (Perry County, 762 square miles; part of Mobile County, 461 square miles) and 760 square miles so far completed in Sumter County, make a total area covered by the soil surveys in Alabama of 3,619 square miles.

ARKANSAS.

Miller County, covering 626 square miles, was surveyed during the past year. A considerable part of this area is low-lying land along the Arkansas River, and is subject to overflow. More than 50 per cent of the area is covered by the Orangeburg fine sandy loam, which is well adapted to cotton—the chief product—and to truck, which has not been extensively introduced.

The Stuttgart area, covering 251 square miles, was surveyed during the preceding year, making 877 miles surveyed in the State.

CALIFORNIA.

During the fiscal year the San Jose area, which was begun in the preceding year, was finished, the San Bernardino and Bakersfield areas were completed, and a survey of the Sacramento area is in progress at the time of closing this report.

The San Jose area, comprising a total of 313 square miles, lies in the western central part of the State, in what is known as the Santa Clara Valley. The Placentia sandy loam is the most extensive of the nine types of soil mapped here, covering about 30 per cent of the area. It is one of the most important in the area, from an agricultural standpoint, and is devoted to the growing of the citrus and other fruits. The other types of soil, where irrigable, are also intensively cultivated to a wide range of crops. Irrigation by pumping from artesian wells has had great development in the area, but water is also drawn from the rivers and mountain canyons. The northern part of the area fronts on the Bay of San Francisco, and low-lying lands along this body of water contain considerable alkali. The area as a whole, however, is little affected by accumulations of these injurious salts.

The Bakersfield area, covering 196 square miles, lies in the San Joaquin Valley. Eight soil types were recognized in this area, the three of most importance being in the Fresno series, and occupying about 80 per cent of the total area surveyed. They are devoted to truck, fruit, alfalfa, raisin grapes, and other crops suited to the climatic conditions of the area. Some alkali occurs in the area, confined chiefly

to the heavier soil types, including the Fresno fine sand, Fresno fine sandy loam, Maricopa loam, and Oxnard silt loam. The harmful accumulations of alkali are found in the southern half and northwestern corner of the area. More than 70 per cent of the area contains less than 0.2 per cent of alkali.

The San Bernardino area covers about 700 square miles in the valley by that name, which is one of the largest in southern California. Twenty soil types were recognized in this area. As in nearly all parts of southern California, this valley has a great variety of agricultural products. The crops and their methods of production range from the most intensive cultivation of a very valuable and high-priced crop—the citrus fruits—to the most extensive farming of a low-grade crop, as in the thousands of acres of dry-farmed grain. The greatest amount of alkali in the area mapped occurs in the Perris Valley, where several thousand acres of badly alkaline areas were found. A few small areas also occur along the Santa Ana River, and two districts in Riverside Colony have sufficient quantities to kill citrus fruit.

About 710 miles have been surveyed in the Sacramento area. This, with the areas mentioned above and those surveyed in preceding years, gives a total area for the State of 5,769 square miles.

COLORADO.

The survey of the principal part of the San Luis Valley was completed during the last fiscal year, covering an area of 628 square miles. Five soil types were recognized in this area, all lacustrine in origin, two of which—the San Luis sandy loam and the San Luis sand—occupy 49 and 34 per cent of the area, respectively. Nearly all of the San Luis sandy loam now under cultivation is sown to the cereals or to peas. The San Luis sand when first cultivated grew large crops, but has been generally abandoned on account of alkali. The accumulation of alkali has been due to excessive irrigation—subirrigation being practiced and occurring naturally to a large extent. Practically all the alkali of the area is found on or near the surface, and the land can almost all be reclaimed by a change in the system of irrigation with provision against seepage.

The principal crops of the valley are wheat, oats, peas, barley, potatoes, and wild hay.

DELAWARE.

The work in Delaware during the last fiscal year comprised an area of 314 square miles in Kent County, a little north of the central part of the State. All of the soil types encountered have been previously recognized in other areas surveyed in the Coastal Plain region. The Norfolk loam and the Portsmouth sandy loam occupy the largest areas in this survey, covering 33 and 25 per cent of the area, respectively. Delaware has long been favorably known for the quality and quantity of the peaches which it produces, and this area is situated in the most important fruit-growing section of the State. The Norfolk loam seems to be the most productive soil for this crop. The Kieffer pear stands next to the peach in importance and is rapidly gaining prominence in the area. The soils are also used for berries and truck crops.

FLORIDA.

An area of 485 square miles was surveyed around Gainesville, Fla., principally in the interest of the trucking industry. Six soil types were recognized. The Norfolk sand, which covers 45 per cent of the area, is the most extensive soil type. This soil is well drained, its water supply well regulated, and it constitutes one of the best types for the trucking industry. The Norfolk sandy loam, covering 28 per cent of the area, is adapted to a variety of crops grown in the area. It is especially suited to cucumbers, which are an important truck crop in the vicinity of Williston. Early lettuce is also a very profitable crop on this and other soils of the area. Formerly this was an important orange-producing section of the State, but the industry has not been revived since the destruction of the trees by the heavy freezes of 1894–95. Sea Island cotton is another product of the area.

GEORGIA.

Two areas were completed in Georgia during the last fiscal year.

An area covering 364 square miles was surveyed in the southeastern part of Decatur County, adjoining the survey made in Gadsden County, Fla., during the preceding year. This area includes some of the lands on which shade and open grown Sumatra wrapper and Cuban filler leaf tobacco have been successfully produced. Nine types of soil were recognized in this survey, nearly all of which are in the Norfolk and Orangeburg series.

The Dodge County area, containing 489 square miles, lies in the south-central part of the State. Four types of soil were recognized in this area, all of which have been found in earlier surveys. The principal type is the Norfolk sand, covering 56 per cent of the area. The soils are light and sandy, and with diversification of crops should become of much greater value than at present. Cotton is the principal crop, and the light soils are not as well adapted to this product as to truck and small fruits.

The above-described areas, together with the areas heretofore surveyed, make a total area covered by the soil surveys in Georgia of 1 610 square miles.

IDAHO.

The Blackfoot area, Idaho, completed during the last fiscal year, contains 428 square miles. Three soil types were mapped, all of which have been previously recognized. The Yakima loam, covering about 88 per cent of the area, contains nearly all the farming land of this area. Alfalfa, wheat, oats, potatoes, and barley are the principal crops, and all produce good yields. The beet-sugar industry is now being developed in the area. From present indications apples will soon be a paying crop. This area, together with the Boise and Lewiston areas previously surveyed, gives a total for the State of 1,135 square miles surveyed and mapped.

INDIANA.

Three areas were completed in Indiana during the last fiscal year.

The Madison County area (435 square miles) lies in the central part of the State. Five types of soil were recognized in this area; the prin-

cipal one—the Miami clay loam—covers over 83 per cent of the area. This type is easy to cultivate and is very productive, being used for general farming purposes. The chief products of the area are corn, wheat, oats, and grass. One new soil type, the Madison loam, was established, which is particularly adapted to trucking crops.

The Boonville area, containing 264 square miles, lies in the southwestern part of the State and borders on the Ohio River. Six soil types were recognized in this area. Corn, wheat, and tobacco are the principal products, and with careful methods of cultivation good yields are made.

The Scott County area, containing about 190 square miles, lies in the southern part of the State. Five soil types were recognized here. This area was originally covered with a heavy growth of timber, and only within the last ten or fifteen years has the cultivation of the land received the whole attention of the farming class. The agriculture is general, corn, wheat, oats, and clover and timothy hay being the leading products. The tomato has become an important special crop, the product being consumed by local canning factories. A number of hogs, but little live stock of other kinds, are shipped from the county.

The above-described areas, together with Posey County, make the total area covered by the soil surveys in Indiana 1,276 square miles.

IOWA.

Two surveys were completed in Iowa during the year. The Cerro Gordo County area contains 567 square miles. Stock raising and the extensive production of grain and grass are the chief industries, while dairying and the keeping of poultry have increased in importance in recent years, and promise to continue to develop in the future. Seven soil types were found, one of which, the Marshall loam, occupies two-thirds of the entire area of the county. This is one of the most widely distributed types of the prairie soils, and is adapted to general farming purposes. Corn, oats, and hay are the principal products.

The Tama County area (720 square miles) lies nearly in the center of the State. The soils of this area are also adapted to general farming, corn, oats, and hay being the principal crops. The agricultural interests show greater development in the northern part of the county; the southern part, having a more broken surface, is better adapted for pasture, and is more generally used for this purpose. Five soil types are found in this area, one of which, the Marshall silt loam, covers nearly 67 per cent of its extent. This type is one of the best corn soils in the Middle West.

Two areas were previously surveyed in this State, viz, the Dubuque area (440 square miles) and the Story County area (576 square miles), making a total area covered by the soil surveys in Iowa of 2,303 square miles.

ILLINOIS.

Besides the completion of the Knox County survey, soil maps of three additional counties were completed. As in preceding years, the work was carried on in cooperation with the Illinois experiment station.

Knox County, situated northwest of the center of the State, is rich agriculturally. The soils are almost entirely silt loams, and therefore

not adapted to a wide range of crops. Corn is the principal one, oats and hay being secondary. The soils are well adapted to these crops, but a more systematic rotation should be practiced. The more hilly areas should be devoted to pasture and fruits.

Winnebago County (526 square miles), lying in the extreme northern part of the State, has a greater diversity of soils than any other county in the State surveyed during the year. Much attention is here given to stock raising and dairying. The sandy soils offer an opportunity for the more extensive growing of truck.

McLean County (1,158 square miles) is situated north of the center of the State, in the "corn belt." The soils are very similar to those of Knox County. Corn is the great crop, and this county ranks among the first in the country in the production of this staple. Oats and hay are quite extensively grown. More systematic rotation of crops should be practiced. The hilly portions are best adapted to pasture and fruits.

Johnson County (339 square miles) is one of the extreme southern counties. The soils are not diversified, 77 per cent of the area of the county being Memphis silt loam. Corn, wheat, oats, hay, fruits, and vegetables are the principal products. The uplands are not well adapted to general farm crops, but fruits, vegetables, and hay do well, and more attention should be given to these.

A small area of 72 square miles in Calhoun and Jersey counties was mapped in connection with the O'Fallon area, Missouri.

These counties, together with the areas heretofore surveyed (Tazewell, 645 square miles; Clinton, 491 square miles; St. Clair, 650 square miles; Clay, 460 square miles; Sangamon, 866 square miles; and 480 square miles in Knox County), make a total area of 5,925 square miles covered by the soil surveys in Illinois.

KANSAS.

There were surveyed in this State during the last fiscal year three areas, situated in widely different parts of the State.

The Parsons area (398 square miles), in the southeastern part of the State, has six types of soil, ranging in texture from clay to fine sandy loam. The area is devoted to general farming, corn, hay, wheat, and oats being the leading crops. The more sandy soils are best adapted to truck and fruits. The acreage in alfalfa is being increased from year to year. The area is as yet somewhat undeveloped.

The Russell area (270 square miles) is located slightly west of the center of the State. The soils are very uniform in occurrence, and the relation of the different types to the topographic features of the area is very noticeable. The stiffer upland soil is recognized as the best wheat land, while the bottom lands are invariably cultivated to corn, alfalfa, Kafir corn, and sorghum. The rougher sections are utilized for pasture.

The Garden City area (331 square miles) is situated in the southwestern part of the State in the region of the Great Plains. The upland soils are very uniform, while the bottom lands show many variations. South of the Arkansas River the country is covered almost entirely by sandhills, while north of this stream the soil is a silt loam. Owing to the semiarid climate farming is not carried on to a great extent outside of the river bottoms, and the prairies are devoted to

grazing. In the bottoms good crops of alfalfa, wheat, potatoes, sugar beets, and vegetables are grown. Macaroni wheat is being tried, and should prove a success, as the rainfall here averages nearly 20 inches. The full agricultural development of the area can only be secured by irrigation.

The total area covered by the soil surveys in Kansas is 1,463 square miles.

LOUISIANA.

Two areas were completed and a third—De Soto Parish—was in progress at the close of the fiscal year.

A survey was made of Acadia Parish, containing 636 square miles. This parish lies in the southwestern part of Louisiana. Seven types of soil were found, mostly fine sands and silts. The Crowley silt loam, covering 60 per cent of the area, is a typical rice soil. The production of rice is more fully developed in this area than anywhere in the Southwest, but there is need for a systematic experimentation in cultivation and fertilization in this belt. Besides rice, cotton is the only crop of importance.

An area of 310 square miles was surveyed around New Orleans during the year, 100 square miles being surveyed in this same area during the preceding year. Much of this area is marshy, and this survey was made with a view to ascertaining the productiveness of these lands and their adaptation to different crops. Six soil types were found, the Sharkey clay covering over 60 per cent of the area. This type when diked and well drained is a strong soil, suited to general farming and dairying. It is especially adapted to rice.

A survey of De Soto Parish was in progress at the end of the fiscal year, about 500 miles having been surveyed at that time.

Including the Lake Charles area (202 square miles), Ouachita area (605 square miles), and those mentioned above, there was a total area covered by the soil survey in Louisiana of 2,353 square miles.

MARYLAND.

With the exception of a small area (29 square miles) which was surveyed in connection with the Leesburg area, Virginia, no work was done in this State during the last fiscal year. The total area which has been mapped in Maryland amounts to 2,663 square miles.

MASSACHUSETTS.

The survey in the Connecticut Valley which was in progress at the end of the fiscal year 1903 was completed, making a total of 796 square miles mapped in this State. Thirty-six per cent of the area is covered by stony loams adapted to pasture. The remainder of the area is covered largely by sands and sandy loams adapted to the growing of truck and tobacco.

MICHIGAN.

The Pontiac area, which was only begun at the close of the fiscal year 1903, and 240 square miles of Saginaw County have been surveyed during the last fiscal year.

In the Pontiac area the soil types are numerous and their arrangement intricate. They embrace a wide range in texture and there is,

therefore, an opportunity for a wide diversity of crops. The adaptability of the soils to different crops has been pointed out in the report.

The survey of the Saginaw area was in progress July 1 and 240 square miles had been completed. Besides the completion of the Saginaw area it is planned to extend the work during the present field season to include several other areas. The work is being done here principally in the interest of the sugar-beet industry. It is purposed to make a close study of the soils in order to determine which types are best adapted to the growing of sugar beets.

The areas given above, together with areas heretofore covered (Allegan County, 828 square miles, and 30 square miles of the Pontiac area), make a total area of 1,375 square miles surveyed in Michigan.

MISSISSIPPI.

Two areas were completed in Mississippi during the last fiscal year.

The Biloxi area (615 square miles) covers about two-thirds of Harrison County, the middle Gulf coast county of Mississippi. The area is sparsely inhabited, and little attention has been given to agriculture. Lumbering, turpentine distilling, and charcoal burning are the leading industries. Within the last two years interest in trucking has been awakened. The survey has shown that over large areas the soils are well adapted to this purpose, and the extension of this industry will prove much more profitable than the growing of general farm crops, to which the soils are not especially adapted.

The Jackson area (737 square miles) has remarkably uniform soil conditions, 87 per cent of the area being covered by one soil type. Cotton and corn are the principal crops. A wider extension of forage crops and the growing of vegetables and fruits are recommended.

These, together with areas already surveyed, bring the total area covered by the soil surveys in Mississippi up to 2,669 square miles.

MISSOURI.

Two areas were surveyed in Missouri during the last fiscal year.

Shelby County (511 square miles), situated in the northeastern part of the State, does not contain a great variety of soils, 66 per cent of the area being covered by one soil type—a silt loam. Hay is the most important crop and occupies probably 80 per cent of the improved land. Corn, oats, and wheat are grown to a considerable extent. Orchard fruits have proved a success, and more attention should be given to this industry.

The O'Fallon area (600 square miles), situated near the mouth of the Missouri River, embraces a large area of bottom land along this stream and the Mississippi River. These bottom lands are very productive, but much of them is in need of drainage. Upon the upland the production of orchard fruits is receiving more and more attention each year.

With the area already surveyed (Howell County, 919 square miles), a total area of 2,030 square miles has been covered by the soil surveys in Missouri.

NEBRASKA.

During the last fiscal year the initial survey was begun in Nebraska and two areas were completed, while the survey of a third, the Kearney area, was in progress on July 1.

The Grand Island area (446 square miles) lies in the southeastern central part of the State. The upland soils are formed principally from the loess, and are largely silt loams. In the Platte River bottoms they contain more sand. General agricultural crops are grown. Alfalfa and sugar beets are also produced with success. The adaptation of the sandy soils to the production of truck is not appreciated by the farmers of the area.

The Stanton area (323 square miles), situated in the northeastern part of the State, has, over 50 per cent of its area, soils very similar to some of those found in the Grand Island area. The crops produced and agricultural interests are very much the same. The raising of stock is given considerable attention.

There had been completed 426 square miles of the Kearney area at the close of the fiscal year. The total area surveyed in the State is 1,195 square miles.

NEW YORK.

During the last fiscal year the work has been carried on in four different parts of the State.

The remainder (285 square miles) of the Long Island area, comprising the western two-thirds of the island, was finished. This embraces one of the leading truck-growing areas on the Atlantic seaboard, and the report contains much information of value to those operating in this line of agriculture in areas where the practices are less advanced. The area has soils of wide differences in texture, and the adaptability of the soils to crops has been recognized by the farmers, and is fully set forth in the report.

The Syracuse area (416 square miles), like the Long Island area, has a great diversity of soils. The character of the crops differs widely, but closely follows the physiographic and textural features. The rolling hills and plateau lands are largely devoted to general farming, dairying, and apples; the flat lands to truck, tobacco, and small fruit, while the clays of the forelands are used almost exclusively for hay.

A small area (160 square miles) along Lake Champlain was surveyed in connection with the Vergennes area, Vermont.

On July 1 last work was in progress around Auburn, and 125 square miles had been completed.

These, together with areas previously surveyed, make a total area of 2,544 square miles surveyed in New York.

NORTH CAROLINA.

The work in this State was carried on, as heretofore, in cooperation with the North Carolina department of agriculture. During the last fiscal year one area was completed and another begun.

The Asheville area (497 square miles) lies in the mountainous section of the State, and a large part of it is too rough and stony for general agriculture. The soils are best adapted to fruits and pasture, and in some of the coves and upon the mountain slopes apples are being grown with profit. There is an opportunity for the greater development of the fruit and dairy interests.

A small part of the Saluda area (190 square miles) was surveyed, but discrepancies were found in the base map, and it was thought best

to wait until the revised copies of the United States Geological Survey topographic sheets could be obtained before finishing the work.

In the earlier surveys of the Craven area ordinary road maps were used as bases, but in 1903 the United States Geological Survey was able to supply, in advance of publication, an excellent topographic base map of the whole area, and a party was detailed to review the early surveys and adjust the soil types to this new base.

The above detailed areas, together with areas previously surveyed, give a total of 5,333 square miles surveyed in North Carolina.

NORTH DAKOTA.

The only work done in this State during the last fiscal year was the completion of the Jamestown area.

The Jamestown area (386 square miles) lies in the east-central part of the State. Wheat is the most important crop. Macaroni wheat has been introduced, and bids fair to become an important rival of the older varieties. Although a number of soils occur, 65 per cent of the area is covered by one type. Agriculture has been extended to this area within the last few years, and the report gives many valuable suggestions to the farmers.

The total area completed in this State at the close of the last fiscal year was 1,242 square miles.

OHIO.

Three areas were mapped in this State during the last fiscal year.

The Ashtabula area (340 square miles), lying along Lake Erie in the extreme northeastern part of the State, has soils very similar to those of the Chautauqua grape belt in New York. Nearly 80 per cent of the area is covered by the Volusia loam, which grows good crops of timothy, oats, wheat, and rye, being especially adapted to cereals and grasses.

The Coshocton area (560 square miles) is rather hilly. Upon the uplands the soil is very uniform. Hay, wheat, oats, and corn are the principal crops. The raising of cattle and sheep is a prominent industry.

The Wooster area (500 square miles) is in the glaciated region of the northeastern part of the State. Nine types of soil were recognized, seven of which belong to the Miami series. This gives a wide range in the texture of the soils, and consequently an opportunity for a diversity of crops. The adaptability of the soils to different crops has been pointed out in the report.

The total area surveyed in Ohio up to July 1 was 2,755 square miles.

OREGON.

The only work done in this State was the completion of the remaining 60 square miles of the Baker City area. No great variety of soils was encountered. Generally speaking, the crops grown are adapted to the soils, though, as the region is essentially a stock-raising country, much land now devoted to grain could be more profitably planted to cultivated grasses. Considerable amounts of alkali occur in the area. In the cultivated valleys the chief constituent is the alkaline carbonate, or black alkali. The reclamation of the alkali areas can be readily secured by the employment of proper methods.

The total area covered by the soil survey in this State is 446 square miles.

RHODE ISLAND.

A survey of Rhode Island was begun in April last. On June 30, 500 square miles, or, approximately, half the area of the State, had been mapped. It is expected that the survey of the entire State will be completed this fall.

SOUTH CAROLINA.

The work of the soil survey was extended in South Carolina during the fiscal year 1903–4, by the completion of the Charleston and Orangeburg areas, and by work begun, and still progressing, in the Lancaster area. The area covered by these surveys amounts to 1,159 square miles, which, added to areas previously surveyed—Abbeville, 1,006 square miles; Campobello, 515 square miles; and Darlington, 599 square miles—gives a total for the State of 3,279 square miles.

The Charleston area (400 square miles) covered the islands and part of the mainland near the coast around Charleston. Here Sea Island cotton is the staple crop, with certain truck crops of secondary, but important, interest. The unique methods of cultivation employed in growing cotton of this type and the peculiarities of soil formation in this area make it of more than usual interest and instructiveness.

The Orangeburg area includes a part of Orangeburg County, which is situated south of the central part of the State. The principal crop is cotton, and in the northern part of the area surveyed there are some excellent cotton soils and many prosperous plantations. In the southern part of the survey there are extensive areas of wet, marshy lands. In recent years some bright tobacco has been produced, and but for the ruling high prices of cotton it is believed that this industry would already have become of considerable importance. The Bureau is experimenting in the growing of another type of tobacco—the Cuban filler leaf—on a soil that is believed to be peculiarly adapted to the production of a high-grade tobacco of this class.

The work in Lancaster County had only just begun at the time of closing this report, and but 50 square miles had been mapped.

The total area completed in this State July 1 was 3,191 square miles.

TENNESSEE.

Up to the beginning of the last fiscal year but one area, the Clarksville area (547 square miles), had been surveyed in Tennessee. In the fiscal year the following surveys were completed:

The Davidson County area (501 square miles): By far the greater proportion of the soils in this area were found to be similar to important types already mapped in the limestone regions of Tennessee and other States. Much of the area consists of very stony soils. General agriculture and tobacco are the chief interests. There would seem to be opportunity for development of the fruit-growing interests, especially on the stony soils.

The Pikeville area (440 square miles) lies in the south-central part of the State, and includes parts of the Sequatchie Valley, the Cumberland Plateau, and Walden Ridge. A large proportion of the lands is unimproved, and agriculture has not developed as in some parts of the State. The principal products of export are beef cattle and hogs. Some wheat, corn, and sorghum are grown, but almost entirely for

home consumption. A few vegetables are grown for market, and there are wide areas of cheap land admirably adapted to the production of truck crops and small fruits on a commercial scale. There is room not only for the introduction of new crops, but also for improvement in the methods used in growing the staple crops, which now yield on the average much less than could be produced on the soils with more careful cultural practices.

The Greenville area (655 square miles) lies in the northeastern part of the State. The details of this survey are not yet at hand.

Altogether surveys have been made in Tennessee covering 2,143 square miles.

TEXAS.

The soil survey in Texas has been extended by the completion of three areas.

The largest of these is the Austin area (705 square miles), which includes most of Travis County and parts of Williamson, Bastrop, Caldwell, and Hays counties, thus lying mostly in the Texas black prairie belt. The area was formerly an important grazing section, but for a number of years cotton has been the chief interest. The rich black soils of the prairie are admirably adapted to this crop, and, notwithstanding the lack of crop rotation and careful cultural methods generally, seem to show no dimunition in productiveness. The appearance of the boll weevil in numbers, especially in the northeastern part of the area, where the yield of cotton, because of damage done by this insect, shrank to a tenth of the normal, is causing great uneasiness among the planters and a strong desire to know more of the soils and their adaptability to other crops.

On two important types of bottom soils along the Colorado River considerable quantities of the truck crops are grown under irrigation, while in the rougher, stony areas of soil grazing beef cattle is still a source of income.

The San Antonio area (484 square miles) is situated in Bexar County, about 125 miles northwest of the Gulf of Mexico, and the same distance northeast of the Mexican boundary line. Twelve types of soil occur in this area, some of them being inherently very productive. The agriculture is hampered, however, by the uncertainty of the rainfall, which is often too scanty to mature crops properly, the area lying within the semiarid region of the State. Formerly this was an important grazing district, and San Antonio is still the center of the stock-raising interests of southwestern Texas. The increase in land prices and the fencing and cultivation of the range lands have caused a decline in the industry locally. Cotton is probably the chief crop grown at present. Vegetables, grown under irrigation for local consumption, mainly in the city of San Antonio, are a source of considerable income to a few farmers and gardeners. The irrigated area is, however, relatively small. The water used is drawn from the springs near San Antonio, from artesian wells, and to some extent from the San Antonio River. The practice of irrigation is on the increase, but the water supply is at present limited.

The Paris area (548 square miles) covers the northern part of Lamar County—one of the northeastern border counties of the State. The soils are varied and productive. Cotton is the leading crop, and the region is noted for a particularly fine quality of staple. This area is

also a part of the black prairie belt, but has a fair proportion of light sandy soils, which have given rise to thriving early truck and fruit industries. A few large herds of cattle are still kept in the area, but the stock interests are as nothing compared to what they were in the days of the free range. In parts of the area large quantities of prairie hay are cut and baled for shipment.

A survey of Anderson County, of which 827 square miles have already been mapped, is now in progress.

The total area surveyed in Texas up to July 1, 1904, is 4,297 square miles.

UTAH.

The fourth area to be surveyed in Utah was the Provo area, finished early in the last fiscal year. The area lies around Utah Lake and extends over parts of Utah and Juab counties, about halfway between the surveys previously made in the Sevier Valley to the south and around Salt Lake to the north. The soils are similar to those of the Salt Lake area, and were correlated with types as established there. They are, as a rule, very productive, though their natural fertility is impaired to some degree in a few places by lack of drainage; in others by the presence of alkali, and in others by an inadequate supply of water for irrigation. Sugar beets are an important crop, while alfalfa, barley, and other small grains, vegetables, especially potatoes, and fruits are all successfully grown.

A survey of Bear River Valley was in progress at the time of closing this report. The 133 square miles finished there and the 173 square miles necessary to complete the Provo area constitute the area actually covered in Utah during the last fiscal year. Prior to that 991 square miles had been mapped, making the total for the State to date 1,297 square miles.

VERMONT.

The first survey to be undertaken in Vermont has just been completed. It covers a part of the forelands along Lake Champlain and extends back from the lake a short distance into the foothills of the Green Mountains. A small area across the lake in New York is also included in the sheet. The soils are mainly of the heavier classes and are excellent grass and hay soils. The chief product is hay, large quantities of which are sold annually. Butter and cheese are also important, while the secondary products are lamb, wool, beef, pork, and apples. This survey will be known as the Vergennes sheet.

VIRGINIA.

The Leesburg area (351 square miles) lies mostly in Loudoun County, Va., but includes also small areas in the adjoining counties of Maryland and West Virginia. Comprising, as it does, parts of the Piedmont Plateau, mountain, and limestone valley provinces, the soils are many and of varied characteristics and adaptations. This is one of the most prosperous agricultural regions of Virginia. The agriculture is general in character, with important stock-raising and dairying interests, and somewhat less important fruit-growing interests. There is opportunity for specialization, particularly in peaches, apples, and small fruits.

Work was also in progress in tide-water Virginia, where, on York Neck, 305 square miles had been mapped at the time of closing this report. Prior to the last fiscal year the Albemarle, Bedford, Norfolk, and Prince Edward surveys, with a combined area of 2,775 square miles, had been completed, and this, with the work finished to July 1, 1904, gives a total for the State of 3,431 square miles.

WYOMING.

The initial work in Wyoming was completed during the last fiscal year, when a survey was made of 309 square miles, lying along the Big Laramie River in Albany County, a border county in the southeastern part of the State. The dominant industry of the area and of the country surrounding it has been and still is stock raising. Agriculture is of comparatively recent development and is to-day relatively unimportant. Crops can be grown only with irrigation, and there is a shortage in the water supply during a part of the season. The soils contain some alkali which wasteful methods of irrigation have tended to accumulate. Hay—alfalfa and native grasses—wheat, oats, barley, and potatoes are the leading crops. Little of these crops is shipped out of the area, the supply usually being insufficient to meet the local demand. Owing chiefly to the high altitude of the area, fruits and tender vegetables can not be grown.

PUBLICATION OF THE REPORTS AND MAPS.

At the last session of Congress provision was made to print in the form of "advance sheets" the several reports as they are prepared—500 copies for the use of each Senator from the State, 2,000 copies for the use of each Representative of the Congressional district or districts in which the survey is made, and 1,000 copies for the use of the Department of Agriculture. Although this act was passed too late to materially influence the printing of the report of the work for the field season of 1903, it will very greatly facilitate the distribution of the report and is proving a very advantageous way for the printing and distribution of the report of the work for the field season of 1904, the manuscript of the first reports of which have already gone to the Public Printer.

RECLAMATION OF ALKALI LAND.

In my last report attention was directed to the important results obtained in the reclamation of alkali soils by underdrainage and surface flooding. This work was undertaken as an object lesson to farmers in those irrigated districts of the West where any considerable trouble has been experienced with the rise of alkali and the consequent depreciation in the value of land. As pointed out in my last report, the first year's work was very satisfactory, while the results of the past year have again proved the wisdom of inaugurating these demonstration experiments in removing alkali. Great interest has been aroused in the work on every side, and frequent inquiries have been received from farmers owning alkali land asking instruction as to the best methods to prevent the further deterioration of their lands and advice as to the reclamation of tracts now wholly unproductive.

On the reclamation tracts established during 1902–3 much progress has been made during the past year, and indications point to the complete reclamation of the land on the different tracts at an early date. Near Salt Lake City, Utah, on the 40-acre tract owned by Mr. E. D. Swan, the results of our work have been especially gratifying. Circular No. 12, issued February 2, 1904, fully describes the condition of the land before reclamation had been attempted and the results accomplished up to that time. As stated in this circular, the first 4 feet of soil of the 40 acres was shown by a detailed soil survey to contain in September, 1902, more than 6,650 tons of soluble salts. In May, 1903, there had been removed by surface flooding nearly 50 per cent of the total amount of alkali, while in October, 1903, 82 per cent had been removed, or, in other words, only 1,221 tons remained in the surface 4 feet of the entire 40 acres. The greater proportion of alkali was washed out of the surface foot, but even the fourth foot of soil had lost 69 per cent of the alkali originally present. From September, 1902, to May, 1904, more than 12,400,000 cubic feet of water had been added to the land, while of this amount nearly 7,000,000 cubic feet were discharged by the drain tiles, the remainder sinking through to the deep subsoil. The quantity of salts carried away in the drainage water is estimated at more than 4,400 tons.

A soil survey made in the spring of 1904 showed but little change in conditions since the fall of 1903. The land was sufficiently sweetened, it was believed, to allow the growth of any shallow-rooted crop. Accordingly the land was disked and harrowed and one-third sowed to oats, one-third to barley, and the remaining third to wheat. The cultivation and seeding operations were carried on by the Utah experiment station, which has charge of all cropping experiments, the reclamation of the tract being carried on in cooperation with that office. The seeding was not completed until May 25, too late perhaps to insure the best results. The land was not in the best condition for cropping, as the continued use of water had rendered it difficult to bring the soil into a good state of tilth. The results of the seeding were, however, quite satisfactory, and on many of the checks more than 90 per cent of a stand was secured. The wheat made the best growth, oats the next, and the barley the poorest. On all of the checks the character of the growth seems to indicate that but little of the original alkali remains in the surface foot. On the checks where a poorer stand was obtained flooding will be resumed at once, but on those checks having the better stand the crop will be allowed to mature, after which flooding will be carried on to remove the remaining alkali from the lower depths. By this fall it is believed all of the land will be reclaimed to a depth of 4 feet, and next spring the entire 40 acres will be seeded to alfalfa, this crop making a better growth in this part of Utah when seeded in the spring than when seeded in the fall. When a good stand of alfalfa is secured the land will be returned to the owner and the experiment closed.

During the past year another circular was issued describing the progress of the reclamation work at Fresno, Cal. A 20-acre tract, owned by S. M. Toft and N. H. Hansen, situated about 2½ miles south of Fresno, was selected for this demonstration. The circular fully describes the serious conditions as they exist about Fresno, and outlines briefly the damage that has been wrought by seepage water and the rise of the dreaded black alkali. In spite of the many difficulties encountered on this tract

considerable progress has been made, and indications point to the complete reclamation of the entire tract. Pumping was necessary to remove the drainage water, as the land has but little fall, and to dig a gravity outlet would have been very expensive. The first season much trouble was experienced by the tiles filling up with the soil, which acts like quicksand. During the present season, however, the water has passed more readily through the soil, and the soil has become more compact over the tiles, hence they have not required cleaning so frequently. Some checks still contain some black alkali, but as the levees are more secure this year these checks are kept continually flooded, and at the end of the season it is hoped that practically all of the alkali will be removed.

Much of the land is already reclaimed to such an extent that cropping can be carried on, and some experiments have been tried with various crops. In July, 1903, one check was sowed to sorghum and one check to Egyptian clover. The clover did not succeed well, but 50 per cent of a stand was secured on 3 acres. In November, 1903, alfalfa was sowed on 3 acres. This started nicely, although somewhat damaged by frost, and in June, 1904, 85 per cent was making good growth, showing plainly the great change that has taken place in the soil since the beginning of reclamation. On the south end of the tract 5 tons of wheat hay were cut from a 3-acre check, while just north 10 tons of wheat hay (green weight) were harvested from a similar sized check. These two checks are perhaps more fully reclaimed than the remainder of the tract, but prior to the first flooding in March, 1903, they supported only a growth of the resistant Bermuda grass and were considered too badly alkaline for ordinary crops.

On July 3, 1904, Mr. W. H. Knox, in charge of this work, reported that the drains were then working well and were carrying a large amount of alkali from the field; that the crop yields for the season to that date were 13,400 pounds of alfalfa hay, valued at about $33, and 15 tons of wheat hay, valued at $127.50, and that there was a prospect of obtaining about 10 tons more of alfalfa during the present season, and from $10 to $20 worth of corn and sorghum.

Considering the worthless condition of this land a year ago, the necessity of maintaining flooding operations, the fact that crops had to be grown on small checks where the land had been sufficiently sweetened, and that the planting of the crops was limited to such times as the condition of the reclamation would permit, this is a very satisfactory indication of progress in the work.

One and one-half acres of the Fresno tract are in water grass (*Leptochloa fascicularis*), and from our experience this crop is to be recommended while reclamation work is being carried on. The land can be kept continually flooded and at the same time some return can be gotten from the sale of the water-grass hay. Analyses of this grass indicate that it compares very favorably with other forage plants. In addition to the work of reclaiming the land and experimenting with various crops a careful study of the underlying water table is being carried on; this will give valuable data for any future drainage work planned in the Fresno district. A series of 3-inch wells were sunk in the locality that is experiencing the most trouble with the rise of seepage water. Weekly readings of these wells show just what sections would be most benefited by a general drainage system.

On the Gervais tract, situated 3 miles south of North Yakima,

Wash., it is estimated that continuous flooding from July 20 to November 15, 1903, washed approximately 70 per cent of the total salts below a depth of 4 feet. Here again much valuable land has been ruined by seepage waters and the surface accumulation of black alkali. The tract selected was land that had always been considered too badly alkaline to produce crops. At the time of the installation of the drainage system it was largely covered with greasewood and salt grass, both indicative of large amounts of alkali. Flooding was resumed again May 27, 1904. As a good supply of water is available for flooding and the water moves freely through the tiles it is thought the reclamation will be completed this fall. When reclaimed this land will have a value of more than $150 per acre, whereas before it only only served as inferior pasture land with little if any real value. Since the results of the reclamation work have become so noticeable, similar salt-grass pasture lands near by have greatly risen in value, as it is readily seen that they can be converted within a year or two into valuable alfalfa and fruit lands.

A report on the soil survey of a part of the Salt River Valley, Arizona, published in 1900, pointed out the trouble experienced by the farmers with alkali, and made specific recommendations for the reclamation of the affected lands in that district, but no attempt had been made in this direction up to the beginning of the Bureau's experiments. It seemed that this would be an excellent place for demonstration work, and accordingly a tract about 2½ miles south of Tempe, consisting of 20 acres of land belonging to Mr. W. T. Cummings, was chosen, and the installation of the drainage system completed in February, 1904. The cost of laying the drain tile was about $32 an acre. This is somewhat higher than in the case of the other experiments so far undertaken, but no tile could be secured nearer than southern California, and the freight rates amounted to one-half of the entire cost of installation. If tile can be furnished at some point nearer Tempe the cost of underdrainage will of course be materially lessened, but even at the above figures it is believed that such a system of permanent reclamation will be practicable, considering the benefits derived from it. Soon after the work was completed the water supply ran short, and only enough water could be had to flood the tract once. For a number of years the water supply has been limited in the Salt River Valley, and this is especially the case at present, for no rains of any consequence have fallen since September, 1903. Rains usually occur during July and August, when there is an abundance of water for irrigation, and the supply is usually maintained throughout the fall and winter months. It is during this time that the reclamation work can be carried on to the greatest advantage, for at this period of the year the farmers use less water for irrigating crops, and consequently the supply for flooding will be much greater. From the character of the soil and from its tendency to stand well in bank no difficulty should be experienced in holding the water on the land, and the early reclamation of this land is looked for.

In June, 1904, steps were taken toward the establishment of another experiment on a tract at Billings, Mont. Billings is situated in the Yellowstone River Valley, and great progress has been made in growing alfalfa for winter feed for the sheep and cattle that pasture on the adjoining ranges during the summer months. Shortly after irrigation was begun alkali commenced to appear, and the ground water rose

rapidly, water-logging wide areas of the soil to such an extent that it soon had to be abandoned. An examination of certain parts of the valley made by the Bureau in 1897 and 1898 showed the extent of the damage, and when, in 1902, a detailed soil survey was made around Billings it was found the trouble had greatly increased. Even in the two years that have elapsed since the soil survey was made many fine alfalfa fields have been abandoned, and now are heavily incrusted alkali flats. The farmers are fully aware of the seriousness of the situation, and many tracts of alkali land were offered for the demonstration station. No tile could be purchased in the vicinity, and freight rates were almost prohibitive, but the local brickmakers at once recognized that by putting in tile machinery a demand could soon be created for their goods. The situation was canvassed among the leading landowners, and many agreed to purchase tile if it could be cheaply secured. As a result tile machinery was ordered at once and the contract for furnishing the tile to be used in the experimental work awarded to the local manufacturers. Reclamation of a suitable tract will be in progress early in July, and so great is the interest taken in the matter that many landowners have signified their intentions of installing similiar tracts as soon as they shall see proof that the alkali lands can be reclaimed by the methods used by the Bureau.

Briefly, to summarize the work of the past year, practical demonstration work has been carried on in the three tracts established during the preceding year, while another tract has been installed at Tempe, Ariz., and preliminary arrangements have been perfected for a fifth tract in Montana. The Bureau has every reason to feel encouraged with the progress made in this reclamation work, as in many of the districts the farmers are following our suggestions and drawing up plans to install drainage systems to free their land from the alkali it contains. The work is thoroughly practical and farmers at once realize its value as soon as the reclamation is assured. In each of the tracts, in spite of varying soil, alkali, and climatic conditions, the work has made good progress. New problems have had to be solved from time to time on the different tracts, but the general principles of the work are the same and the experience gained has been very useful in making recommendations to the farmers in new and untried districts. There has been a growing demand for demonstration work; in fact, requests for more reclamation tracts have been made than the funds allotted to the work would cover. As soon as the reclamation work now in progress is completed, other tracts will be selected in the different districts where the work will be of the greatest value.

TOBACCO INVESTIGATIONS.

This branch of the Bureau has an organization of twelve tobacco experts and operated last year in six States. The work on the various stations is under the control of a chief expert with headquarters at Washington, who supervises the work, under the direction of the Chief of the Bureau.

The most important work during the past year has been the experimental growing of Cuban tobacco on certain soils in South Carolina, Alabama, and Texas. These soils—the Orangeburg sandy loam and the Orangeburg clay—are apparently very similar to certain of the best tobacco soils of Cuba. In February, 1903, in cooperation with

the leading farmers, the Bureau planted 13 acres in Texas, 3 acres in Alabama, and 3 acres in South Carolina. This tobacco has all the characteristics of the Cuban leaf, and in the Texas and Alabama tobacco the percentage of leaf having a fine aroma is very encouraging, 62 per cent of this crop being pronounced very fine.

As the results from this experiment seemed encouraging, the Bureau decided to continue the work. Accordingly, in January, 1904, arrangements were made with certain farmers in the above-mentioned States to lease sufficient land for the continuation of this work. In the State of Texas the Bureau has three tracts—at Nacogdoches, Crockett, and Giddings—with a total of 12 acres. In Perry County, Ala., and Orangeburg County, S. C., the Bureau has control of 3-acre tracts. All of these tracts are under the direct control of the Bureau, and the tobacco being grown is the property of the Department of Agriculture, and will be used as samples to ascertain the commercial value and desirability of the leaf for filler purposes.

Investigations have also been continued in the Miami Valley of Ohio. In experiments with the Cuban type of filler tobacco 10 acres were planted on the Miami clay loam, yielding about 600 pounds per acre. Owing to the heavy nature of the leaf it is impossible at present to judge of its aroma, as it will require several months to age. The tobacco raised the year before on this type of soil is only just ready for the manufacturer. The aroma has been pronounced good, but it is the opinion of the Bureau's experts that it is a little too heavy for the taste of the general public, and the aim this year is to try to produce a lighter leaf.

By far the most important work performed in Ohio has been the introduction of the bulk method of fermentation. The quantity of tobacco handled according to the method prescribed by the Bureau of Soils has increased to 8,358,160 pounds. The following table will show the amounts handled under direction of the Bureau for the last three years:

Year.	Pounds.
1902	655,200
1903	4,204,860
1904	[a] 8,358,160

[a] Zimmer Spanish, 4,426,560 pounds; Little Dutch, 582,600 pounds; Seed leaf, 3,349,600 pounds.

This tobacco is Zimmer Spanish, Gebhart seed, and Little Dutch, varieties used in the manufacture of cigars. The substitution of the bulk method of fermentation for the past practice of case fermentation not only prevents loss from rot and imperfect curing, but also results in a general improvement in the several grades of this tobacco.

Up to this date the Bureau's work has been along the lines of improving the methods of culture and handling of cigar tobaccos, but this year demands have been made upon the Bureau to assist the growers of our heavy and export tobaccos. The low percentage of tobacco produced for plug wrappers and the poor prices obtained by the majority of the growers led the Bureau to make investigations into the production of this type of tobacco, the object being to increase the yield per acre and the percentage of the higher grades, which would be a benefit to the grower and the manufacturer. Appomattox County,

Va., was selected as being the most promising field for this work, it being the section where most of the finest plug wrappers are grown, and also being convenient to the Richmond and Lynchburg markets.

The Bureau has established a 5-acre tract in this county, where different fertilizers and different methods of culture are being used, to ascertain which will give the best financial results to the grower. It is the intention of the Bureau to extend this work in the future to the other States producing the shipping types of leaf.

The work of producing a wrapper leaf of the Sumatra type in the Connecticut Valley having all the qualities demanded by the trade has again been taken up by the Bureau. This work on the part of the Bureau was considered finished after the sale of the 1901 crop in Hartford, when satisfactory prices were obtained; but owing to two years of unfavorable weather for the growing of tobacco and adverse trade conditions, which were largely out of the control of the growers, the tobacco has failed to a certain extent to receive the entire support of the manufacturers, although one of the larger companies engaged in this industry has disposed of 62 per cent of its 1902 crop at paying prices. The Bureau, still believing that a desirable wrapper can be grown in Connecticut, and at the request of those still engaged in the industry, has this year established an experimental field of 4 acres at Tariffville.

Owing to the recent tendency on the part of the trade to wrap the better grades of cigars with the Cuban rather than with the Sumatra style of leaf, 1 acre of this plot was planted to Cuban seed tobacco. Tobacco of this type, grown under shade in Connecticut, was exhibited by the Department at the Louisiana Purchase Exposition at St. Louis, and, according to unofficial advices, was awarded the grand prize as being a leaf of the highest standard of excellence for cigar wrappers.

In connection with this matter, the Bureau of Soils has been making an investigation of the demands of the market and the practicability of building up a demand for Connecticut shade-grown tobacco. Recent sales of this tobacco have been made, principally in New York and Philadelphia. The following table shows the distribution of nearly 300 bales of shade-grown tobacco from Sumatra seed, and the average price per pound of the lots as sold:

Number of bales.	Price per pound.	Number of bales.	Price per pound.
FOR DOMESTIC USE.		FOR EXPORT.	
17	$1.75	14	$0.70
1	1.65	30	.32½
24	1.50	100	.30
3	1.45	144	
3	1.40	TOPS.	
4	1.35	90	.10
60	1.25	14	.08
1	1.00	104	
1	.75		
16	.62½		
4	.35		
134			

This table shows that 134 bales have been sold for domestic use at an average price of $\$1.26\frac{8}{10}$ per pound, the highest price being $1.75 per pound for light wrappers, and the lowest price 35 cents per pound

for short-sized second quality leaf. The 144 bales sold for export at an average price of $0.34\frac{4}{10}$ consisted of tobacco of a quality not suited to the home market, consisting principally of sand leaves and short-sized, flimsy tobacco. Nearly all of this tobacco was shipped to the German market. The 104 bales sold at an average price of $0.09\frac{7}{10}$ consisted of short top leaves, the tobacco having no wrapper quality, and being useful only as an inferior filler.

The tobacco experts of the Bureau of Soils see no reason to change their belief that the method of growing tobacco under shade in the Connecticut Valley will produce a wrapper leaf of great excellence, which can be economically used by the trade, and it would seem that the industry should be established upon a commercial scale.

In cooperation with the Bureau of Plant Industry another plot of tobacco is being grown in Connecticut for the purpose of establishing a perfect type of leaf and for seed selection.

It is the purpose of the Department, if the results of the work for the fiscal year 1904 warrant, to carry on the experiments in filler tobacco in the Southern States and possibly in Ohio upon broader lines; also to extend the work of improving the quality and yield of the shipping tobaccos in those States where this type of tobacco is being grown.

Great difficulty is experienced by the Bureau in this branch of its work from the scarcity of men having the necessary knowledge of all branches of the tobacco business and from the small appropriation allotted for this line of investigation.

WORK OF THE LABORATORIES.

The laboratory of soil physics has been engaged during the past year upon the investigation of the movement of water in soils and methods for studying its translocation; the diffusion and transpiration of soil gases and the efficiency of these two agencies on soil aeration; and the adsorption of dissolved salts and the influence of the adsorbed salts in the soil upon plant assimilation. This laboratory has also been charged with the mechanical analyses of soils, and with the construction and repairing of apparatus for the soil survey and the alkali reclamation work, and has assisted in the planning of experiments, the designing and construction of apparatus, and in the reduction and interpretation of the results obtained in the soil demonstration work.

MECHANICAL ANALYSES.

During the past year mechanical analyses have been made in the laboratory of over 2,000 samples of soils, which is an increase of more than 30 per cent over the number of samples examined last year. These samples consisted principally of those sent in by the soil survey parties, but a number of samples have also been examined at the request of the Departments of War and Navy, the United States Geological Survey, and various offices in the Bureau of Plant Industry. The method of mechanical analysis has been thoroughly examined for the purpose of determining possible sources of error, and with a view to increasing its simplicity and efficiency. Many requests have been received for a description of the method of mechanical analysis employed by the Bureau, and a bulletin on this subject which is now practically completed will soon be ready for publication.

PHYSICAL BASIS FOR SOIL CLASSIFICATION.

A scheme for soil classification based upon the mechanical composition of soils has been prepared in cooperation with members of the soil survey. This classification was tested during the past winter in connection with the work of correlating the soil types and gave most promising results. Its use will tend to promote uniformity in the classification, diminish the number of soil types, and lessen the labor of correlating the various soils. In connection with this scheme of classification, the plan has been adopted of having the field men send in immediately to the laboratory preliminary samples of soils regarding the classification of which they are in doubt. These samples are analyzed and the results returned promptly to the field men, giving them, in connection with the classification scheme, the necessary data for determining the class to which the soil belongs.

MOISTURE INVESTIGATIONS.

The desirability of an accurate and reliable method of measuring the changes in the moisture content of a soil becomes evident in nearly every investigation in soil physics. The electrical conductivity method heretofore employed by the Bureau has the disadvantage of being influenced by changes in the amount of dissolved salt in the soil moisture as well as in the water content. A method which is independent of the amount of salt in the soil solution has been tried during the past year with satisfactory results and gives promise of being developed into a valuable laboratory method. The method consists in measuring the electrostatic capacity of a small condenser, of which the moist soil constitutes the dielectric, by means of electric waves, the capacity of the condenser being dependent upon the amount of moisture present in the soil and independent of the salt content.

Another method which has been developed for investigating the movement of water in soils consists of an artificial root, giving for the first time a means of causing a movement of soil moisture analagous to that produced by the roots of a plant. This apparatus thus provides a method of determining the relative water movement in different soils and its relation to productiveness, a question of importance in semi-arid regions. Samples of the moisture of the soil, with its dissolved salts, may also be obtained by this apparatus, enabling one to determine the composition and concentration of the soil solution under actual field conditions undisturbed by dilution or the addition of another solvent.

INFLUENCE OF ADSORBED SALTS ON PLANT ASSIMILATION.

In the investigations on the relation of the concentration of the soil solution to crop production it is of fundamental importance to know whether the plant is capable of feeding directly upon the adsorbed layer of dissolved substances or whether it is wholly dependent upon the concentration of the free portion of the solution. Experiments have been made which show that the thickness of the wall of the root hair exceeds the distance through which the force giving rise to adsorption phenomena is capable of producing an appreciable effect. The plant is not, therefore, influenced by the greater concentration of the adsorbed layer on the soil grains, and the soil solution obtained by the centrifugal machine or by means of the artificial root represents the actual concentration upon which the plant feeds.

CAPILLARY EQUILIBRIUM OF SOILS.

The common practice of expressing moisture content of a soil as a percentage of the dry soil does not give a satisfactory basis for determining or comparing the amounts of water that soils of different textures are capable of supplying to the plant. A centrifugal method has been developed by which the water content of a series of soils can be determined so that they will all be in capillary equilibrium; that is, when put in contact, no interchange of the soil moisture will occur. By changing the speed of the machine another series of moisture contents will be obtained, the soils still being in capillary equilibrium. This method thus gives: First, the moisture contents of a series of soils in capillary equilibrium with a capillary pressure of known magnitude; second, the change in moisture content produced in this series when the capillary pressure is varied by a known amount. It is believed that this method will prove of much value in the study and comparison of the great soil types, and it is proposed to undertake an investigation of the more important types during the coming year.

DIFFUSION AND TRANSPIRATION OF SOIL GASES.

A study of the diffusion and transpiration of soil gases through various types of soil has been made with a view to determining the extent and relative importance of these two agencies in the aeration of soils. The results indicate that in field conditions transpiration due to changes in barometric pressure is a much more important factor in the ventilation of the soils than diffusion. The rate of transpiration is to a very great extent dependent upon the texture, physical condition, and porosity of the soils. For a given soil, when the porosity is altered by compacting the soil the rate of transpiration of air varies as the sixth power of the interstitial space. The rate of diffusion of air and carbon dioxid into each other through soils appears, on the other hand, to depend mainly or wholly on the amount of free pore space, and be proportional approximately to the square of the free pore space.

LABORATORY OF SOIL CHEMISTRY.

During the past year the major part of the work of the laboratory of soil chemistry has been in assisting, on the chemical side, important investigations carried on in soil management and demonstration work; developing methods for observing and controlling plant growth: the effects of mineral nutrients, the soil atmosphere, and the organic content of soils upon plant production.

The investigations on the solubility of mixed pairs of salts have been continued, and six papers on this subject have been published in journals during the past fiscal year. Of especial interest in this connection are the investigations which have been carried on upon the solubility of slightly soluble phosphates, which have always been held to be of great importance as constituents of the soil, and which have a most important bearing on fertilizer practice. It has been definitely shown that these substances have not been properly understood heretofore, as they do not show the same solution phenomena as do ordinary salts, but possess special characteristics of their own of great technical agricultural importance. Moreover, the particular properties which these substances evidence have been shown to be very probably possessed also

by the major part of the minerals of the soil which furnish plant nutrients, and the working out of the problems presented by these slightly soluble phosphates has thrown important light upon the mechanism of rock and mineral disintegration, soil formation, and the availability of mineral nutrients in the soil to crop production. A large field for investigation of great importance both to agriculture and geology is opened up through these investigations.

The laboratory has continued the investigation of methods for the detection and estimation of very small amounts of mineral substances, such as would be extracted from soils by water. Five papers in this line of work have been published during the year, and it is safe to say now that the methods for this character of work have been put in a very satisfactory condition.

The study of the toxic action of soluble soil constituents upon plants has been continued during the past year, with special reference to the action of acids, both organic and inorganic, upon young plants or seedlings of some of our common field crops. A paper based upon the results of this investigation has been published. Work of a similar character has also been prosecuted upon the action of those salts commonly found in the "alkali" of arid regions upon the germination and growth of field crops, with a view to determining the kinds of crops best adapted to soils affected by "alkali." It has been shown in the course of these investigations that the treatment of seeds with solutions of certain salts not only greatly increases their germinating power when planted in the soil, but apparently much increases their resistance to the action of "alkali," and it is believed that this line of investigation will lead to results of great economic importance for agricultural practices in arid regions. Much valuable information has been obtained for the use of the field parties engaged in the "alkali" reclamation work, but it has not been deemed advisable to publish these results until they have been further investigated under field conditions.

The importance of the organic content of soils, both from the chemical and physical point of view, is being more generally recognized every day. In the absence of any satisfactory method for determining the amount of organic matter in the soils, a special investigation of this subject has been made in the laboratory and a method devised and thoroughly tested, and a description of it has been published in one of the technical journals.

The laboratory of soil chemistry has responded to the usual demands of a routine nature made upon it in answering the queries of properly authorized parties as to the chemical characteristics of soils, drainage, and irrigation waters, etc. Every sample of soil described in our annual field reports is now examined in this laboratory as to its organic content, the presence of lime carbonate, the presence of "alkali," both as to kind and amount, or any other chemical features of a striking or unusual character, using for the most part methods which have been devised in this laboratory. In spite of the fact that the field parties have been much restricted in the number of samples which they are permitted to submit to the laboratory, the continued development of the field work has nevertheless kept the number of samples annually submitted to the laboratory large, requiring the entire time of a number of our assistants and a part of the time of every one connected with the laboratory.

SOIL MANAGEMENT.

The work in soil management is being conducted for the general purpose of developing new methods or improving known methods for the treatment and management of soils to obtain improved yields of crops. It is not proposed in this work to demonstrate the efficacy of present known methods. Such demonstrations must, in the nature of the case, have rather a local and limited value, and there are other well equipped agencies, such as the State experiment stations and our own field surveys, which are doing much to bring these matters to the attention of the people.

The specific objects of the work now in progress are the developing of methods of soil inspection as to their chemical and physical condition and cultural needs, and the demonstration of the practicability of new methods when applied to actual growing crops. Several field parties have been sent out from time to time in this work, and several such parties are now in the field. In the present stage of the work these parties are principally engaged in testing the value of methods of examination for the requirements of soils.

It is obvious that the prosecution of such work requires a very thorough knowledge of the constitution of soils and their mineral and organic components, and the effects resulting from physical, chemical, or biological processes. These phenomena can best be studied in the laboratory, where conditions can be controlled, and the results then tested and developed in a practical form in the field. The soil moisture, the soil atmosphere, the nature and kinds of organic matter and the changes which it undergoes are all being carefully studied, as well as the mineral characteristics to which is usually given the most attention, as evidenced in the widespread recognition of the value of commercial fertilizers.

It has been shown that plants experience more difficulty in taking up water and dissolved substances from some soils than from others, and that in general the ease with which absorption takes place from aqueous extracts of soils is in the same order as the known productivity of the soils. Absorption is generally increased from soil extracts which have previously been sterilized, but such media are especially favorable to the growth of molds and other organisms inimical to plants. Absorption is hindered by the presence in the soil of some forms of organic compounds resulting from processes of decay under certain conditions. Absorption is increased in the presence of some apparently inert substances, such as charcoal, ferric hydrate, etc. Added organic matter decomposes very differently in different soils; in some soils much humus is formed, in others the production of humus is small, but the probable formation of decomposition products of a deleterious nature is relatively large.

In the working out of these results methods were devised which seemed applicable to a field study of the characteristics of a soil. Our parties are now testing these methods on several types of soil, and the work, so far as it has progressed, promises results of such character as to justify demonstrations with fields managed in accordance with the conclusions obtained from our examinations.

CLASSIFICATION OF SOILS OF THE UNITED STATES.

It is the practice of the Bureau to issue annually a book of instructions for the field parties, containing a concise description of all soil types which have been recognized, as an aid in the classification and mapping of soils.

During the past year, as the Bureau had surveyed 74,795 square miles, including representative areas in all but three or four of the States, considerable time was devoted to a careful revision of the soil types, so as to bring out the relationship between the soils by placing them in groups and series.

This annual book of instructions for field agents is becoming more and more valuable, and, although it is not recognized as a publication—that is, it has no serial number and is not included in our list of reports—it is coming to be in great demand, not only by colleges and experiment stations, but as a text-book of instruction in all agricultural colleges and as an aid to individuals interested in the soils of different parts of the United States and in their relation to crops.

The last revision of this work shows that the Bureau has recognized 297 distinct types of soil, differing in their characteristics, in their relation to crops, or in the methods of cultivation necessary to produce the best results. These types have been arranged in 31 series, in which the soils are related in point of origin, with a considerable number of miscellaneous soils of local origin, which so far have not been arranged in series, as their relationship is uncertain. These 31 series and the miscellaneous soils have been thrown into 10 great groups, covering the most important physiographic divisions of the United States. It is believed that this systematic study of the soils of the United States will be a great aid in the development of the agricultural interests of the country.

REPORT OF THE ENTOMOLOGIST.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., August 25, 1904.

Sir: I submit herewith an executive report covering the work of the Division of Entomology for the fiscal year ending June 30, 1904, dividing it, in accordance with your instructions, into the following sections:

(1) A brief review of the operations carried on during the fiscal year 1904.

(2) An outline of the plans proposed for the work of the Bureau for the fiscal year 1905 under appropriations already made for that year.

(3) Suggestions as to the work recommended for the fiscal year ending June 30, 1906, for use in preparing estimates.

Respectfully,

L. O. Howard, *Entomologist.*

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR.

The work of the Division of Entomology during the last fiscal year of its existence as a Division may be classified as follows:

Work on insects from abroad.
Work on scale insects.
Work on the Mexican cotton boll weevil.
Work on the cotton bollworm.
Work on other cotton insects.
Investigations of insects damaging forests.
Investigations of insects injurious to vegetable crops and small fruits.
Work on insects injurious to stored products.
Work on insects affecting shade trees and ornamental plants.
Work in silk culture.
Work in bee culture.
Experimental work with insecticides.
Investigations of insects in their direct relation to the health of man.
Miscellaneous work.
Work on the exhibit for the Louisiana Purchase Exposition.

WORK ON INSECTS FROM ABROAD.

ASIATIC LADYBIRD ENEMY OF THE SAN JOSE SCALE.

The interest which has been aroused by the importation of the Asiatic ladybird enemy of the San Jose scale (*Chilocorus similis*) continues. This insect has maintained itself in numerous colonies in the South during the winter. An examination in Georgia in May of this fiscal year indicated the general presence of the beetle in many of the orchards where it had been liberated. Its rapid multiplication had been prevented, however, in many instances by the subjection of the orchards in question to spraying operations with lime, sulphur, and salt wash, or other washes, exterminating practically all of the scale food, and hence leading to the starvation of most of the beetles. Nevertheless, the beetle has gained foothold and will probably multiply and remain ready to make progress wherever the scale food proves to be abundant. Its spread by artificial distribution of colonies has been continued as far as material has been available, partly from collections of colonies made in the southern orchards referred to and to a small extent from the local colony maintained in the experimental orchard attached to the office in Washington. Very few colonies, however, have been available from the latter source, for the reason of the practical extermination last year of the San Jose scale in this orchard.

The benefits to be derived from this ladybird have been very distinctly decreased in the case of the Washington colony by the losses occasioned by a native parasite. So far this parasite seems not to have attacked the ladybirds in the southern orchards. The colonies established in northern States have not given good account of themselves, probably more from unfavorable orchard conditions or lack of food than from any inability of the ladybird to withstand the northern winters. The efficiency and general use of the lime, sulphur, and salt wash will prevent the rapid extension and multiplication of this ladybird enemy of the San Jose scale. For the wide distribution and rapid increase of this imported beetle the necessary conditions are large infested orchards which shall be left untreated with insecticide washes so that they may furnish plenty of food. These very conditions are, of course, entirely antagonistic to successful commercial production of fruits, and now that a ready means of keeping such orchards free from scale at small expense by the use of the lime, sulphur, and salt wash has been shown, very rarely will such orchards be left for the purely experimental purpose of propagating this imported ladybird enemy of the scale; and such a course could hardly be recommended, in view of the fact that the ladybird is, after all, still on a purely experimental basis. Nevertheless, its importation and successful establishment in this country can not work anything but good, as it is in its native home an important agency in the control of this scale pest, and will become more efficient in America as it becomes more widespread and more abundant.

THE BLACK SCALE PARASITE IN CALIFORNIA.

The distinct success of the imported enemy of the black scale (*Scutellista cyanea*) has been continued during this year. My principal assistant, Mr. Marlatt, visited California during November and Decem-

ber of 1903 and made a special examination of the work of this beneficial insect. A report on this investigation is given in Bulletin 44 of this office. The points of greatest interest shown in his notes are that at the height of the breeding season (August and September) the life cycle of the insect is but 55 days, and that during the colder season or winter these insects enter a period of semihibernation, which may extend over three months. The latter fact has a distinct bearing on the usefulness of this parasite. The feature of greatest anxiety was as to its ability to pass the winter season, during which, in the case of many citrus groves at least, there would be no scale food. This problem seems to be solved by the hibernation of the insect as noted. On the other hand, it is shown that where conditions are favorable—that is, in sunny situations and where the food supply exists—activity continues throughout the winter. The parasite has spread of its own accord also very often from one citrus orchard to another, and has been found, furthermore, breeding in numbers in the black scale by roadsides on various weeds, which are sometimes infested by this scale insect, and also in fields of Chili peppers similarly infested. Many citrus orchards have substantially been freed of the black scale by the agency of this imported insect, and the greatest hopefulness is being felt throughout southern California of the practical extermination of the black scale in the near future. This scale insect, it will be remembered, is the worst pest of the citrus and olive orchards in southern California. There seems to be no possible reason for doubting the establishment of this beneficial parasitic insect in southern California, and its present and prospective great usefulness. The authorities in southern California have been most active in breeding and distributing it, as many as 40,000 insects having been distributed from the office of the board of horticultural commissioners of Los Angeles County alone, and distributions to a less extent have been undertaken elsewhere, notably by Mr. Craw, of San Francisco.

OTHER IMPORTED INSECTS.

The European scale-feeding moth (*Erastria scitula*), accounts of which have been given in former reports, does not seem to have made any very startling developments and does not yet give promise of distinct usefulness. It was liberated in several places in California, and the preliminary reports showed that there was a favorable chance of its becoming established, and something creditable may still result from it. Neither the European ladybird (*Coccinella septempunctata*) nor the Australian ladybird (*Leis conformis*) have multiplied to any notable extent. The benefit to be obtained from the former is open to question, as it is an omnivorous feeder and will eat its own larvæ or the larvæ of other ladybirds as readily as it will plant-lice.

OLDER IMPORTATIONS.

Of the older importations in California the Vedalia enemy of the white scale, the first of the importations which resulted in great benefit, is maintaining its usefulness. It is being regularly bred by Mr. Craw and by some of the county horticultural officials for prompt introduction into any locality where the white scale reappears. The rapidity

with which a colony of scales is cleared up by this insect is something marvelous, a few weeks only being sufficient for it to free a considerable area of infestation. The older black-scale ladybird parasite introduced into California, namely, *Rhizobius ventralis*, has confined its range of usefulness to the moister coast region and does not seem to have any special value in the drier regions near the mountains. A new service which this imported beetle is rendering is seen in instances of efficient work against *Pulvinaria innumerabilis* (the cottony maple scale) on apple.

The fig-fertilizing insect continues to hold its own in the vicinity of Fresno, Cal., where it was originally imported, and has made possible the raising of another very large and fine crop of Smyrna figs. The development of this fig industry seems perfectly assured, but the accomplishment of its spread will be gradual, since some years must elapse before the trees recently planted can reach a sufficient size to be of practical value.

AN ENEMY OF THE COTTON BOLL WEEVIL.

During the fiscal year Mr. O. F. Cook, botanist in charge of investigations in tropical agriculture, Bureau of Plant Industry, was authorized to visit Guatemala, and such other portions of Central America as might be necessary, for the purpose of investigating and studying the nature of varieties of cotton grown by the Indians which appeared to be resistant to the boll weevil. It was suggested that a member of the staff of the Division of Entomology accompany Mr. Cook, but it seemed to the Chief of the Division that since Mr. Cook himself had made an especial study of entomology and was well informed upon many entomological questions, the expense of such a sending would not be necessary, and he therefore urged Mr. Cook to watch carefully for any natural enemies of the boll weevil which might exist in Central America. In April, 1904, in Alta Vera Paz, Guatemala, Mr. Cook discovered an ant of the family Ponerida which seems to be a very efficient enemy of the cotton boll weevil, and which he studied carefully for some time, and then with great care and with most commendable labor he succeeded in collecting 80 colonies, containing about 4,000 ants, which he colonized in an ingenious but simple way in glass jars and conveyed to Texas. They have been placed under restrictive conditions at several different points in Texas, and the most careful study and experimentation will be undertaken under the supervision of Mr. Cook, who has been assigned to the Bureau of Entomology for this purpose. The ant itself, on being brought to Washington, was recognized by experts of the Bureau of Entomology as *Ectatomma tuberculatum*, a tropical ant of rather general distribution throughout Central America and northern South America, which had a number of times been taken by collectors, but of which nothing had been published beyond mere scientific descriptions. Its specific habits were unknown to entomologists before they were discovered by Mr. Cook. The introduction of this species into Texas is very important and offers a field for most interesting experimental work. The practical results can not be foretold, but even if this new importation proves only moderately effective it will have been of very considerable value to the cotton industry.

WORK ON SCALE INSECTS.

The work with scale insects has been actively prosecuted during the year. This group of insects includes some of the most important enemies of fruit trees and shrubbery, and in the South of various field and garden crops. The experimental work with remedies has been discussed under the subject of "Insecticides," more particularly with reference to the San Jose scale. There has been the customary amount of determination of material sent in from all parts of the United States and from many foreign countries, necessitating a good deal of careful preparation and microscopical work. To facilitate such determinations it has been necessary to put the Museum collection of scale insects into better shape, and a good deal of work of preparation and classification has been done during the year. The small size of most scale insects and the necessity of making careful microscopic preparations of them before determination can be made renders their determination by field observers difficult, if not impossible. In the United States the Department of Agriculture is practically the only public institution where there are sufficient collections and data to make such determinations. The result is that material for identification is received in quantity constantly from State entomologists, instructors, students, collectors, and horticulturists.

WORK ON THE MEXICAN COTTON BOLL WEEVIL.

Under the provision of Congress setting aside $30,000 for the continuation of the investigation of the boll weevil, in addition to a similar investigation of the bollworm, two more or less distinct lines of work were organized in Texas in addition to other lines undertaken elsewhere. Seven experimental farms were organized. These were located at Victoria, Wharton, Austin, San Antonio, Calvert, Willspoint, and Hetty, aggregating 558 acres of cotton. The organization of these farms enabled the Department to test various methods of controlling the weevil under conditions of soil, climate, and rainfall quite different from those in regions where experimental work had previously been carried on. Although there are many minor divisions of the cotton region in Texas, based upon the considerations that have been mentioned, the seven localities referred to represent the principal ones. At Victoria and Wharton, the typical river bottom lands, in the southern part of the State, where the normal occurrence of volunteer cotton furnishes food for the weevils during the winter, were represented. At San Antonio the experiments were with cotton under irrigation. At Austin the typical black prairie land of that portion of the State was represented. At Calvert the experiments were performed upon the typical soil of the river valleys in Texas, where the presence of timber and moist climate and almost exclusive production of cotton caused the weevil problem to be more serious than anywhere else. At Willspoint and Hetty the high rolling prairie land and the river bottom land of the northern part of the State were represented, respectively.

The investigations of the life history of the boll weevil, upon the knowledge of which any system of control of the pest and any modifications of the present system must naturally be based, were continued

at the laboratory at Victoria, where a specially trained assistant devoted his full time to the study of all features of the habits of the insect that offered any hope of suggesting means of combating it. Many poisons designed to destroy the boll weevil were tested at the laboratory, as were many machines in the experimental fields of the Department. The investigation of the status of the boll weevil in Cuba was carried on by Mr. E. A. Schwarz in the hope that some effective parasite might be discovered, or that some variety of cotton might be found which might be in some way resistant to the attacks of the pest. The exact spread of the boll weevil into new cotton regions was watched carefully. A special investigation regarding the extent to which birds feed upon the boll weevil was instituted, and several hundred stomachs of birds shot in cotton fields were collected.

The laboratory and field work of the season resulted in the publication of the following bulletins and papers:

Farmers' Bulletin No. 189, "Information concerning the Mexican cotton boll weevil."

Bulletin No. 45, Bureau of Entomology, "The Mexican cotton boll weevil."

Yearbook, "The status of the Mexican cotton boll weevil in the United States in 1903."

Under the provisions of the appropriation of $250,000 to enable the Secretary of Agriculture to meet the emergency caused by the ravages of the Mexican cotton boll weevil, which became available on the 15th of January, 1904, it was possible to enlarge the work considerably. Twelve entomologists are now engaged in the work in Texas, in addition to a number of other assistants. The following lines of work have been instituted:

EXPERIMENTAL FARMS.

During the several years that the Bureau of Entomology had conducted experimental field work in Texas a cultural system of raising cotton in spite of the presence of the boll weevil was perfected. During the previous year, for example, the Bureau succeeded in demonstrating by several striking examples that cotton may still be profitably produced in Texas in boll-weevil districts. In not one of the seven experimental farms did the crop fall appreciably below the average production in the United States before the weevil came into Texas—i. e., about one-half bale to the acre. In spite of this degree of success obtained in the field experiments of the Bureau, it was found that the system must be modified materially to meet the conditions in various parts of the State. Various features give the problem of raising cotton in some localities aspects entirely different from those possessed by it elsewhere. In order, consequently, to perfect this system and ascertain the variations necessary in all localities, it was decided to increase the number of these experimental farms from 7 to 13, aggregating 1,077 acres. This cotton is planted under a contract, which gives the Department practically complete charge of the ground. In addition to this contract cotton, about 200 acres have been planted on a cooperative basis without a special contract, the Department furnishing a portion of the seed and fertilizer required.

LABORATORY.

A number of additional assistants have been added to the laboratory force to be engaged in testing remedies and furthering the present knowledge of the details of the life history of the weevil.

STUDY OF PARASITES.

The possibility of artificial propagation of parasites has been studied carefully. The special feature of this work is in connection with *Pediculoides ventricosus*, which the Mexican entomologists consider a very valuable adjunct in fighting the weevil in that country.

ISOLATED COLONIES.

A special investigation of the possibility of hindering the spread of the weevil in the United States, and of eradicating isolated colonies, when such a procedure is deemed advisable, is one of the most important lines of work undertaken. Two entomologists are kept constantly in the field in connection with this work.

DANGER FROM GINS.

Gins are probably the most important factor in causing the boll weevil to be disseminated through the country. The preliminary investigations of the Department have indicated that this danger may be reduced to a considerable extent by the use of certain devices designed to destroy the pests at the gins. A specially trained and experienced mechanic has been employed in connection with this work. A bulletin regarding the suggestions the Department has to offer will be issued shortly.

INSPECTION.

Very great inconvenience has been caused the interests in Texas, as well as elsewhere, on account of the quarantine laws of the various States devised to prevent the introduction of the boll weevil. A very conservative estimate is that 5,000 carloads of Texas products have been prevented from taking the natural course to the markets in the eastern States of the cotton belt. The Bureau has succeeded in perfecting an arrangement with several States whereby their former absolute quarantines are materially modified. The arrangements consist of a system of inspection of the commodity and of the locality in which it originates. If it is considered perfectly safe to issue authorizations, that is done. Following this system, at the present date the shipment of about 500 carloads of commodities has been authorized.

COOPERATION WITH THE LOUISIANA COMMISSION.

In this work, on the nomination of the commission of Louisiana, five men have been employed to determine the exact extent to which the weevil has invaded the Louisiana cotton fields and to assist in an attempt to eradicate the colonies that are known to exist, as well as such as may be found in the future. The special importance of this work is due to the fact that the weevil is now approaching a region in

Louisiana where there is undoubtedly a more effectual barrier than it will meet elsewhere in the United States. Consequently, if it is possible to stop the spread of the pest at all, it will be possible along the western border of the State of Louisiana.

WORK ON THE COTTON BOLLWORM.

Although not referred to in my last executive report, special work was begun by direction of Congress upon the cotton bollworm in the late spring and early summer of 1903. A single investigator was put in charge of this work and established headquarters at Victoria, Tex., where the office and laboratory facilities of the boll weevil investigation were available. During the remainder of the calendar year 1903 this investigator worked single handed. With the resumption of field work in the spring of 1904 a portion of the special large emergency cotton appropriation made by Congress was assigned to the thorough investigation of this insect, and the same investigator, with three assistants, established himself at Paris, Tex., where a laboratory was fitted out with the necessary equipment for the study of all phases in the life and habits of the bollworm which seemed likely to throw light on methods of control. The town of Paris was chosen for headquarters from the fact that it is in the heart of the territory most commonly ravaged by the bollworm and for the further reason that at the time it was uninfested by the boll weevil, the presence of which would complicate results of experiments.

Two principal lines of investigation were followed out during the fiscal year: (*a*) Field experiments in methods of control; (*b*) laboratory and field investigations of the life history, habits, and parasitic and predaceous enemies of the insect.

In the field experiments especial attention has been given to the growing of cotton in ways likely to avoid injury from the bollworm and to the securing of definite, presentable results. They were arranged: (1) To determine the possibility of making a crop of cotton before the period of greatest bollworm injury by the early planting of an early-maturing variety of cotton aided by thorough cultivation, thus adopting essentially the same idea which has been prominent in the field work against the boll weevil; (2) to determine the value of spraying or dusting cotton with arsenical poisons; (3) to determine the value of corn as a trap crop in protecting cotton from bollworm injury. Incidentally experiments were made with light traps, poisoned sweets, fumigation of fields with sulphur, and methods of a similar character.

In 1903 this field experimental work was carried on with 50 acres of cotton at Calvert, 50 acres at Willspoint, and 40 acres at Hetty. The principal results of the work conducted on these respective farms were indicated in Farmer's Bulletin No. 191, published early in 1904.

On account of the increased appropriations the field experiments for 1904 were considerably enlarged, and the following acreage was under control: Forty acres at Paris, 100 acres at Ladonia, 30 acres at Hetty, 90 acres at Willspoint, 50 acres at Sulphur Springs, and 40 acres at Pittsburg. These locations represent the "black-wax" soils of north Texas, the gray prairie and post-oak lands of central Texas, the sandy lands of east Texas, and the rich bottom lands along the streams of north Texas.

In addition to the above contract farms, cooperative experiments were arranged as follows: Fifteen acres at Terrell, Tex., 30 at Quinlan, Tex., 40 at Shreveport, La., and 55 at Mound, La., thus making a total of 400 acres upon which crops are being grown in an experimental and demonstrative way in the investigation of this insect. In addition to these there are five or six small areas, comprising about 50 acres, in which the investigation is interested. On these farms tests are being made of various methods likely to insure a crop of cotton.

In the laboratory at Victoria during the latter half of the calendar year 1903 the investigator confirmed the principal points in the life history of the bollworm and added some new facts. Since the beginning of the spring of 1904 the time of two men has been devoted almost exclusively to laboratory investigation, and many interesting points are being determined.

WORK ON OTHER COTTON INSECTS.

While the injuries to cotton by the cotton leaf worm or cotton caterpillar have been in late years by no means so great as during the period from the close of the civil war to 1880, and while no other single cotton insect compares with the cotton bollworm and cotton boll weevil in the amount of damage done to crops, the loss from other cotton insects is considerable, and the full significance of the work of some of them has not heretofore been thoroughly understood. Therefore, beginning with the spring of 1904 and under the emergency cotton appropriation, an investigation of insects injurious to cotton, other than the two principal species mentioned, was begun by the State entomologist of Texas in cooperation with this office. This investigation was carried on to the close of the fiscal year.

INVESTIGATIONS OF INSECTS DAMAGING FORESTS.

The field work of the year was conducted, as in the preceding year, in cooperation with the Bureau of Forestry. In the course of its cooperation the Bureau of Forestry detailed one field assistant during the entire year and another agent from November 30 to the end of the fiscal year. The Bureau of Forestry also provided funds for the principal traveling and field expenses. The remainder of the field and office forces and the direction of the work was provided by the Division of Entomology.

The work at the field stations was substantially as follows:

At the Black Hills station the work consisted of a continuation of notes on some 200 experimental trees which were felled and girdled in 1902.

At the northwestern station (headquarters at Hoquiam, Wash.) the especial problems under investigation consisted of the damage to forests of western hemlock and highland spruce by the hemlock spanworm, the damage to living hemlock timber by the hemlock bark maggot, the damage to spruce, fir, and other conifers by other bark beetles, and the damage to red fir by bark and wood boring insects.

At the southern station (headquarters at Tryon, N. C.) the especial problems under investigation were damage to southern pine forests by the destructive pine bark beetles, causes of death to chestnut timber in the southern Appalachian region, and damage by wood-boring insects to girdled and felled cypress timber in the Southern States.

In the middle Appalachian station (headquarters at Madison and Kanawha Station, W. Va.) the problems studied were damage to imported mahogany and other timber and lumber by introduced and native insects, damage to hickory forest trees by hickory bark beetles, damage to oak and hemlock by tan bark insects, and damage to commercial and stored hard-wood forest products by powder-post beetles.

At the southwestern station (headquarters at Flagstaff, Ariz.) the principal problem was an investigation of the damage to pine forests by the destructive bark beetles of the genus Dendroctonus.

In the course of this work in forest insect investigations especial cooperation has been entered into with lumbering companies, manufacturers of wooden articles of trade, importers of exotic woods, and forest rangers, which is rendering the work more efficient and bringing it much closer to the people directly interested in its results.

A large amount of office and laboratory work was done in Washington in working up and studying material, specimens, and notes collected during field operations, and in the preparation of manuscript for publication.

The principal results of the past year's work are found in the vast amount of new material in specimens and notes and in the general information, which has greatly advanced our knowledge of the forest insects of the country and places us in position to give our correspondents and the public more reliable information concerning the insects and principal methods of control than has heretofore been possible. The results of the detailed investigations during the year will enable the preparation of a large amount of original matter which, it is hoped, will lead to the prevention of a large percentage of the losses which, from the lack of required information, have heretofore been beyond control.

INVESTIGATIONS OF INSECTS INJURIOUS TO VEGETABLE CROPS AND SMALL FRUITS.

Investigations in this line have been in active progress throughout the year. A special feature of recent work has been on the investigation of insects affecting the sugar beet. A preliminary report on the principal sugar-beet pests has already been published, and investigations are now being undertaken covering the principal sugar-beet growing sections of the United States, from Nebraska and Michigan to the Pacific coast States and Arizona. Approximately, half of the known insect enemies of this crop, which is destined to become a most important staple, including a score or more of insects unknown as beet pests, came under observation during the fiscal year ending June 30, 1904. This work will be continued with a view to a comprehensive report on the subject. Among other insects that were the subject of study during the year were two forms of stalk borers, various forms of white grubs and wireworms, the onion maggot, cabbage maggot, sowbugs, three species new as pests on edible leguminous crops, and two to water cress.

As a part of the work planned for the year, investigations which have been carried on for a considerable time on insects affecting bush fruits, especially strawberry, blackberry, and raspberry, have been under observation. Several of these species are new as small-fruit pests, and others have not hitherto been thoroughly studied, and much

has been learned which adds to our knowledge of their life history, which will have a practical bearing on methods of control.

A popular article on "Insects Injurious in Cranberry Culture" was prepared at the suggestion of the Entomologist by Dr. J. B. Smith, professor of entomology of the New Jersey Agricultural Experiment Station, and issued as a Farmers' Bulletin.

WORK ON INSECTS INJURIOUS TO STORED PRODUCTS.

During the year many complaints were received of damage to export flour by flour beetles and, to a lesser extent, by meal-worms. These complaints emanated chiefly from traffic managers of railroads and export steamers, and the methods of controlling the insects have been the subject of much correspondence. This work will be continued with a view to discovering the best manner of fumigation of insect-infested cars, vessels, and mills. The Mediterranean flour moth, one of the worst of mill pests, has been reported during the year in many new localities, in California, New York, Indiana, Illinois, Iowa, Ohio, Pennsylvania, and Minnesota, indicating that the species is now spreading more rapidly than at any time in the past decade. The standard remedies, with the addition of hydrocyanic-acid gas, are used for its suppression.

WORK ON INSECTS AFFECTING SHADE TREES AND ORNAMENTAL PLANTS.

How best to control insects injurious to shade trees has been the subject of investigation for a series of years, and much work has been done along this line. More complaints of injuries have been received during this season than perhaps in any previous year. Borers are attracting more and more attention, and work is planned as to the effect of bisulphid of carbon on different species of borers and the resistance of various forms of trees to this method of destroying the pests.

Greenhouse insects have been the subject of considerable work in the past and this has been continued. The present year some new or comparatively new forms were under observation, and a number of ornamental plants grown out of doors were also reported injured by pests not previously thoroughly understood. Among this number are three or four insects new as rose pests, one affecting the dahlia, a common species of sowbug which is positively injurious to many plants, a fact that was not appreciated until carefully studied. Cannas have been considerably injured, and have also been studied with regard to their insect enemies. Thrips have been the subject of complaint from florists, and a circular of information has been prepared covering the best methods of control for this very destructive class of pests.

WORK IN SILK CULTURE.

At the close of the fiscal year 1903 reeling operations were about to begin. Two expert reelers had been imported from France, and what was probably a large proportion of the silk crop of the country had been purchased at European market rates. The silk-reeling operations were continued through the remainder of the summer and on into the autumn. Three young American women, one of Italian birth, were taught to reel by the French experts, who returned to France in

the autumn. In the autumn a large supply of bacologically examined eggs were imported from Italy and were hibernated at Washington, and in the spring of 1904 these eggs were sent to all applicants who were able to feed the worms. At the same time mulberry cuttings were distributed to all applicants. At the close of the fiscal year the cocoons raised by American growers were beginning to be received at the Department, and preparations for reeling were again about to begin.

During the winter an article entitled "The Department of Agriculture and Silk Culture," was prepared for the Yearbook of the Department by the Chief of the Bureau, which indicated the steps which the Department had taken during its history at the direction of Congress for the development of silk culture, and also the lines on which it was considered best for the work to proceed in the future.

As was pointed out in the last executive report, the establishment of the silk industry in the United States must be a matter of extremely slow accomplishment. Small appropriations by the General Government will assist in the education of an increasing class of silk raisers. The distribution of mulberry cuttings and the distribution of free silkworm eggs to those who already have mulberry trees at hand should be continued. Eventually enough mulberry trees will be planted properly and in available situations to insure the supply of food for a large crop of the worms; large numbers of people will have become familiar with the best methods of silk raising, and conditions will be ripe for the establishment of commercial filatures. In the meantime, however, and under certain conditions which exist at present, the establishment of some sort of a market for the cocoons is necessary, and it is for this reason that the Department, out of its appropriations, is buying and reeling the crop of cocoons, which, though small at present, will increase as the knowledge of the people increases and as the number of mulberry trees increases.

WORK IN BEE CULTURE.

A great increase in correspondence on all topics relating to apiculture so far occupied the time of the single investigator in this line that original investigations had to be limited. This correspondence covered nearly every phase of the subject, and came from all parts of the country, indicating a very general increase in the interest in this branch, and often required special letters of some length to elucidate the information needed. Frequent assistance was rendered teachers connected with the public schools and normal institutes where the natural history of the honey bee, and in some instances elementary instruction in the general methods of bee management, formed a part of the course. Advice was also given in some instances to agricultural colleges contemplating the institution of special courses in apiculture.

A small number of choice queens of the Cyprio-Carniolan cross, which has proven such an excellent one for the arid regions of the South and West, were sent out. The extremely dry season in southern California has given a severe test of the remarkable energy shown in honey collecting by all crosses containing Cyprian blood; and while it has been necessary in many apiaries, in order to prevent starvation of the colonies, to feed a large proportion of the Italians and hybrids which are chiefly kept in that part of the country, reports have been

sent in showing that 30 to 40 pounds of honey per colony have been found in the same apiaries in hives whose queens were largely of Cyprian blood. The comparative test between the Caucasians and other types of bees, including Cyprians, Carniolans, Italians, and various crosses between these types themselves, and also with accidental matings with black drones, has been continued. The conclusion was reached that the Caucasian race was by far the gentlest honey bee that has ever been brought to this country. Every manipulation necessary in the apiary can be performed with Caucasian colonies without the use of the bee veil, and only in rare instances has it been necessary to apply smoke to control them. Very small quantities were then employed. Under nearly all circumstances it would almost be believed by all observers that these bees were stingless. The test regarding their honey-producing qualities has not been as conclusive, since the past year was, in general, a poor one in this region. However, in so far as the comparison extended, it was found that they held their own in honey gathering by the side of the Carniolan race, although not equaling in this respect the Cyprian crosses mentioned above.

The revival in various newspapers of stories relating to the manufacture and marketing of comb honey has called for repeated denials and a plain statement of the absurdity of the whole matter, as well as the great injury it was working to the apiarian industry of the country. The newspapers and other publications which had inadvertently been led to publish these inaccuracies have nearly always been very ready, upon a proper presentation of the case, to insert a correction. Particular attention has been drawn to the fact that it would cost far more, by any process whatever, to produce a wax, or imitation-wax comb, fill it with honey, or any mixture designed to resemble honey, and then seal it over ready for the market, than it would to maintain and care for an apiary of the required number of colonies to produce through the agency of the bees themselves the same quantity of natural honey. This shows at once the absurdity of the claim that the greater part, or any part, of the comb honey on the market is an artificially manufactured product. This showing has also been followed by a statement of the fact that a reputable firm has for twenty years offered to forfeit $1,000 to any person who could produce artificially an imitation of comb honey which would deceive any person when compared with combs that are filled and sealed by the bees themselves.

Early in the fiscal year the apicultural investigator visited the arid regions of the Southwest, making an extended inspection of apiaries over the whole of southern California, and further investigations in the central and northern parts of the State, with a somewhat cursory view of the conditions of the industry in Oregon, Washington, and Montana. The conclusions resulting from this tour were to the effect that the introduction of various types of bees adapted in each instance to the respective climates and peculiarities of these regions, together with the introduction of certain honey plants from other portions of the world, which from similarity of climate, etc., would be certain to thrive in the portion of the country visited, would result in a very important increase in the honey production of the West. The execution of this work is therefore advisable in the near future.

EXPERIMENTAL WORK WITH INSECTICIDES.

The most important result confirmed by the experimentation of this fiscal year with insecticides relates to the use of the lime, sulphur, and salt wash against the San Jose scale. Experimentation with this wash, long used in California against this scale pest, has been going on in the East for several years, and the results now secured have fully demonstrated its very great value in spite of the somewhat adverse climatic conditions which obtain on the Atlantic seaboard and in the Mississippi Valley regions. It is a winter application, and very inexpensive as compared with the use of oils and soaps, methods hitherto much employed in the East, and has the additional very distinct advantage of notable value as a fungicide, so much so, in fact, that some fruit growers are spraying their peach trees with this wash whether they have scale on them or not, simply for its value against leaf curl and other fungi. The practicability and usefulness of this wash has very largely decreased the terror which fruit growers have hitherto felt for the San Jose scale. A special circular of information relating to this wash has been published. Some further careful experimental work is in progress to determine the most economical method of preparing the mixture and at the same time to secure the most effective combination of the ingredients.

The general employment of the wash has led to a falling off in the use of oils against San Jose scale and other scale insect pests. The distinct value of the petroleum oils against scale insects and for general insecticide applications remains, however, and the outline of experimentation indicated in the report for 1903 is being followed up. The chief merit of these oils is their immediate availability, together with the promptness of their action on scale insects. They will always be of value, therefore, and especially for emergency cases where quick extermination is desired, and for the treatment of smaller plantings where perhaps the more troublesome preparation and more difficult application of the lime, sulphur, and salt wash will act as a bar to its employment.

The possible value of sulphate of copper as a means of controlling mosquitoes was indicated in a report issued by the Office of Vegetable Pathological and Physiological Investigations of the Bureau of Plant Industry toward the close of the present fiscal year. In the employment of this substance to destroy minute algæ in water it was discovered to be of distinct value against various disease germs, and also to have apparently some value against mosquito larvæ. A series of experiments was instituted to test the usefulness of this chemical as a means of destroying such larvæ. These tests, which are still in progress, so far indicate that this substance (copper sulphate) will destroy mosquito larvæ under some conditions. It is most effective when used in practically clear water, and becomes much less effective if the water be foul or muddy, these latter conditions resulting in the quick precipitation of the copper sulphate and preventing its having much, if any, effect. Mosquito larvæ have exhibited great variation in their susceptibility to this poison. Certain species of Culex may be killed when young with very minute proportions (1–5,000,000), well within the possibility of economical application. Other species require much stronger doses, and Anopheles, the malarial mosquito, is least of all

affected by it, being very resistant in the later larval stages and requiring in even clear water a strength of the poison probably beyond the bounds of practical employment in open ponds and streams. Opportunity for testing the poison against the yellow-fever mosquito has not yet offered, but if it should prove effective against this mosquito it may serve a very useful purpose in Cuba and on the Isthmus and other tropical regions as a means of freeing cisterns and other standing bodies of water from danger of breeding this mosquito. The importance of the subject of mosquito control, both from the standpoint of personal comfort and general hygiene, warrants the complete investigation of all the means of control which offer, and such work will be prosecuted with thoroughness.

INVESTIGATIONS OF INSECTS IN THEIR DIRECT RELATION TO THE HEALTH OF MAN.

A certain amount of work in this direction has been carried on during the year, but it has been considered to be secondary to the work which has a more immediate agricultural importance. The principal item which has occupied the attention of the Entomologist during the year has been the study of the geographic distribution of the yellow-fever mosquito, since the importance of such knowledge is very great in its bearing upon quarantine measures and upon the exact limitation of the yellow-fever belt within the boundaries of the United States. The very largely unnecessary alarm which was so prevalent in Texas during the autumn of 1903 and the ignorance displayed by many of the towns by their interurban quarantines, had a serious effect upon the business of the State and also, naturally, though indirectly, upon its agricultural interests. A thorough general knowledge of the causation of the disease and of the habits and life history of the yellow-fever mosquito would practically have obviated all this.

MISCELLANEOUS WORK.

A large number of investigations of minor importance have been carried on during the year.

The results of several years of technical studies of some of our most injurious cereal and forage-destroying plant-lice were made public in an article on these pests. The clover-seed chalcis fly, an insect of wide distribution and one which yearly lessens by a small percentage the clover crop of the country, was studied with the result that it is now positively known to be destructive, whereas hitherto the general belief was that it was parasitic and therefore beneficial.

The cowpea pod weevil has been investigated as thoroughly as necessary for practical results, because of frequent, but happily erroneous, reports of injury nearly throughout the cotton belt, and because it is often mistaken for the cotton boll weevil.

A special study of rice insects, particularly those injurious to this crop in South Carolina, has begun. A species of red spider (*Tetranychus gloveri*) is being investigated as a pest on cotton in the same State. The insects injurious to the pecan industry of the South have been the subject of investigations for several years. The sugar-cane beetle, and incidentally some other species destructive to sugar cane in Louisiana, have been studied by one of the agents of this office.

The nut weevils and some species of similar habits have been investigated and a report has been furnished on them. The work will be continued to ascertain additional facts in regard to the life history to determine better methods of control.

The work on the geographic distribution of insects in the United States is continued, as well as several other minor investigations mentioned in the last report.

The technical work of the expert entomologists has been steadily progressing, and the work on the bibliography of economic entomology has been kept thoroughly up to date. Indexes are being prepared to the series of bulletins. The correspondence of the office has increased still further, and many thousands of letters have been written. This correspondence with farmers and fruit growers is one of the most beneficial functions of the Bureau.

WORK ON THE EXHIBIT FOR THE LOUISIANA PURCHASE EXPOSITION.

An especial effort was made during the fiscal year to arrange a novel and more elaborate exhibit of the work of the Bureau for the Louisiana Purchase Exposition than has ever been sent to any previous exposition from this office. The work of three assistants was devoted to this end through a very large share of the fiscal year, and the exhibit at present installed at St. Louis is undoubtedly the most interesting and commendable one hitherto sent out by this office. The exhibit contains several entirely novel features, and comprises very many cases indicating the life histories of injurious insects and their habits, together with large models of many of the principal injurious forms and vivaria in which injurious and beneficial insects are shown alive and at work.

PROPOSED WORK FOR THE FISCAL YEAR 1905.

The work for the fiscal year 1905, which at the date of this writing is already well under way, will be rather broader in its general outline than the work of the previous fiscal year, which has just been summarized.

An elaborate investigation of insects affecting grains, grasses, and other field crops has been begun, and a special field agent of wide experience and reputation has been put in charge with assistants and means for the best work. This branch will immediately take up a further investigation of the Hessian fly, with the object of determining, by practical experimental work in the sowing of small plats on farms in wheat-growing districts on different dates and in different localities, the best time to sow the wheat in the fall to ward off the attack of the fly; further, to determine the extent to which the pest threatens the spring wheat interests of the Northwest. Some as yet not fully understood points in the life history of the fly will be investigated. Investigations of insects attacking grasses and which menace the first crop of corn planted on sod lands, such as cutworms, wireworms, and webworms, will be begun, and the corn root-louse, clover and alfalfa insects, barley insects of the Northwest, and the general group of insects of the genus Isosoma which affect grains and grasses, will all receive the consideration of this new branch of the work.

Beginning with the spring of 1905 an attempt will be made to begin a definite and systematic investigation of the insects affecting deciduous fruit trees.

An expert has been put in particular charge of all investigations of insecticides and insecticide machinery. This will greatly facilitate and increase the practical work which may be done. It is proposed to follow out the lines of work indicated above with the lime, sulphur, and salt wash and the petroleum oils, and also to carry on an elaborate series of experiments with hydrocyanic acid gas, both in its use for fumigating nursery stock and orchard trees, and also for the riddance in buildings of insect pests and vermin; similarly with the use of sulphur as an insecticide, soaps, the arsenicals, the oily emulsions, etc. This work will be carried out, as in former years, in cooperation with the Bureau of Chemistry, practical field work and experimentation being in charge of this Bureau, and the chemical analyses being in charge of the Bureau of Chemistry.

In forest insects, owing to increased appropriations by Congress, while the cooperation with the Bureau of Forestry will be continued in so far as joint work may be necessary, the Bureau of Entomology will be independent in this line of work in a financial way and will be able to support the entire investigation. Each of the special problems under investigation and referred to in a previous paragraph will require more than one season for completion, but in the meantime bulletins and circulars will be published concerning the results of the work.

In the same way the Bureau will be able during the fiscal year 1904–5 to devote more attention to apiculture than has hitherto been possible. It is proposed as a first step during this fiscal year to establish a model apiary of 50 or 60 colonies of bees at the Arlington Experimental Farm. This apiary will be used in the general conduct of apiarian investigations, and as one of the breeding stations of the races or types of bees which are under observation. Queens of the Caucasian, Cyprian, Dalmatian, Italian, and Carniolan races will be imported for breeding purposes and testing at experimental stations and other places in different sections of the country. Some investigations will be made, and possibly an importation of the bees of the Far East, particularly of the large races commonly known as the Giant Bees of India, one species of which is also found in the Philippines. It is believed that these bees would secure the nectar from flowers with deep corolla tubes, such as the red clover, etc., the sweets in which are, for the greater part, beyond the reach of our ordinary races.

Plans have been made for the procuring and testing in different parts of the country of a number of valuable honey-producing plants which are known to be adapted to portions of our country where intervals in the honey flows occur which may thus profitably be filled in. In this work preference will be given to such plants as have an economic value besides their production of honey.

Numerous complaints of the devastation of apiaries in different portions of the country by diseases, some of which are highly contagious, call for an investigation of the whole subject of bee diseases. Some of these diseases can be dealt with during the coming fiscal year, but others, of a bacterial nature, will require a more extended investigation than the funds will permit at present.

It seems desirable to test the efficiency of artificial heat in the wintering and rapid breeding up of bees. The apiary at the Arlington Experimental Farm will be available in this work. Likewise the construction and testing of hives and accessories adapted to migratory bee keeping.

In addition to the experimental work enumerated above the collection of data regarding the industry in the United States, and particularly as to the honey-producing plants of the country, will be continued. Bulletins on pasturage for bees and the manner of increasing it, with cultural and other notes on new honey-producing plants; on the best methods of rearing queen bees; and on migratory or pastoral bee keeping, have been planned. A limited number of queens of improved races will also be reared and placed for testing at the various experiment stations which do work in apiculture, and likewise in the hands of special agents for testing in particular sections of the country.

In the cotton boll weevil investigation the seven lines of work instituted in pursuance of the provisions of the act making special appropriation of $250,000, which were naturally started at the beginning of the cotton year in 1904, are being continued. While new subjects for investigation are constantly coming to view, this work will lead to the publication of a Farmers' Bulletin dealing with the results of the field experimentations of the Bureau and also the republication of Bulletin No. 45 in a much augmented form. What may be done with this investigation during the latter half of the fiscal year will depend upon Congress. The national menace still exists; the cotton planters of Texas have not as yet become convinced of the benefit to be derived by following the advice which the Bureau is able already to give, based upon its investigations of the past ten years; and therefore further investigation and further demonstration work seems to be necessary. Moreover, the imminent danger of the spread of the weevil to other cotton States indicates the strong necessity that the General Government should keep a force of men in the field working not only to prove and reprove to the satisfaction of planters the effect of its advice, but to continue the study of the insect in its rather rapidly changing environment and to assist in quarantine measures and such other means as are necessary to restrict the spread of the pest.

The bollworm work will continue to the close of the calendar year, so that crops may be gathered and the results of the several experiments ascertained. Extensive experiments with poisons are planned for August, and a special study of the bollworm in the fields has been undertaken. The laboratory investigation is continuing, but it is hoped that in its present scope the investigation will have been completed by the close of the present growing season—that is to say, that upon the basis of this work practical recommendations of methods for the prevention of loss may be made. It will then remain for the cotton planters to avail themselves of the recommendations of the Bureau. The possible desirability of maintaining farms to demonstrate in several localities the value of the methods recommended may appeal to Congress. This, however, is work which the Bureau can not carry on from its current funds and will require the assistance of another immediately available appropriation, such as was made by Congress last winter.

PLANS RECOMMENDED FOR THE FISCAL YEAR ENDING JUNE 30, 1906.

In order to carry out to the very best advantage the work already begun and planned, and in order to undertake some new and important lines of work, a larger appropriation will be necessary, and I respectfully urge that Congress be asked to increase the lump sum appropriated for entomological investigations by $10,000.

I also respectfully suggest that the position in which the Bureau is placed at the present time is anomalous in regard to the matter of salaries. The Chief of the Bureau of Entomology should receive at least the minimum amount given to other chiefs of bureaus, namely, $3,500 per annum, and the statutory roll could be increased to very good advantage, placing it on a par with the statutory rolls of some of the other bureaus.

REPORT OF THE CHIEF OF THE DIVISION OF BIOLOGICAL SURVEY.

U. S. Department of Agriculture,
Division of Biological Survey,
Washington, D. C., September 1, 1904.

Sir: I have the honor to submit herewith a report of the work of the Biological Survey for the fiscal year ending June 30, 1904, with outline of work for 1905, and recommendations for 1906.

Respectfully,

C. Hart Merriam, *Chief.*

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR.

As heretofore, the work of the Biological Survey has been conducted along the three lines laid down by Congress: (1) Investigations relating to the geographic distribution of animals and plants, including biological surveys and the determination of the life and crop belts, in charge of the Chief; (2) investigations of the economic relations of birds to agriculture, in charge of Prof. F. E. L. Beal; (3) supervision of matters relating to game preservation and protection and the importation of foreign birds and animals, in charge of Dr. T. S. Palmer.

SECTION OF GEOGRAPHIC DISTRIBUTION.

The Biological Survey is engaged in mapping the natural life zones and crop belts of the country, for the primary purpose of showing the farmer what crops are likely to prove a commercial success in his locality. The work is done by studying the geographic distribution of native animals and plants in all parts of the country and platting the results on maps showing the distribution of each species. The task of preparing these maps is progressing as rapidly as practicable in view of the limited number of assistants qualified for this branch of the service. In order to obtain the necessary data the status of the various species must be determined by office study, and their ranges laboriously worked out in the field. From the nature of the case many species are worked together—those inhabiting a particular area or region—so that the results are cumulative and their maps will be finished at the same time. The progress already made is gratifying and a large number of maps are now approaching completion. The

individual species maps serve as the basis of a composite map showing the natural transcontinental belts and their more important subdivisions.

During the current year field work has been carried on over wide areas in California, Texas, New Mexico, Colorado, Alaska, and also in several Provinces of Canada and States of Mexico.

In California the field operations for the purpose of securing data for a detailed map of the life and crop zones of the State have been continued under the personal direction of the Chief, along the western slope and foothills of the Sierra Nevada, in some of the interior valleys, and among the Coast Ranges south of San Francisco Bay.

The field parties in charge of Vernon Bailey, chief field naturalist, have practically completed work in western Texas, and are now in New Mexico. In Texas explorations were carried on mainly in the Panhandle region and the southwestern corner of the State in the vicinity of El Paso. In New Mexico field work was done in the northern, middle, and southern parts of the Territory. The work in Mexico, under the direction of E. W. Nelson, was continued, and a supplementary study of the distribution of animal and plant life was made on the southern end of the Mexican table-land, on the Isthmus of Tehuantepec, on the coastal lowlands near Tampico, and in the highlands of Chiapas. The biological exploration of the Mackenzie Basin, including Great Slave Lake and part of the Barren Grounds in the neighborhood of Great Bear Lake, was continued from the previous year. E. A. Preble, who has charge of this work, wintered at Fort Simpson on the Mackenzie for the double purpose of studying the conditions during an arctic winter and of being on the ground to resume field work in the early spring long before the opening of communication with the outside world. These investigations, in connection with recent work in Labrador, and the explorations already carried on by the Biological Survey in the Hudson Bay, Athabasca, and Great Slave Lake regions and Alaska, will form a most valuable chain of observations, making it possible for the first time to understand and intelligently discuss the distribution of the numerous boreal types of animals and plants that inhabit Alaska and enter some of the Northern States. Explorations in Alaska have been continued under the direction of Wilfred H. Osgood, among the northern spurs of the Rocky Mountains, about the upper and middle Yukon, and on some of the islands of southeastern Alaska. A report on the work done by Mr. Osgood about the base of Alaska Peninsula in the summer of 1902 is ready for the press, and will appear shortly.

SECTION OF ECONOMIC ORNITHOLOGY.

In the section of economic ornithology, as in previous years, both laboratory work and field observations were carried on—the former consisting of the examination of stomachs and crops of birds and the tabulation and comparison of their contents; the latter comprising a study of birds in their native haunts. It is believed that it is impossible to place too high a value on an accurate knowledge of the food of our native birds. The best and simplest means of arriving at this knowledge is by the examination of stomachs. Such examinations, supplemented by field studies, have always been a feature of the work of the Biological Survey. Orchards, gardens, and grain fields are

visited for the purpose of determining whether the birds damage crops, attack injurious insects, or devote their energies mainly to the wild fruits and weed seeds of the neighborhood; and collections are made of food materials, including wild fruits, berries, seeds, and insects, to assist in the work of determination in the laboratory.

During the current year examinations have been made of 2,189 stomachs, distributed among various groups as follows:

Quail and grouse	728	Flycatchers	35
Wrens, tits, kinglets	367	Swallows	99
Warblers	307	Miscellaneous	15
Finches	600		
Blackbirds	38	Total	2,189

In studying the food habits of California birds with reference both to the damage they inflict upon fruit and the good they do in destroying noxious weeds and insects, Professor Beal spent seven months (February to October) in the State interviewing many of the fruit growers and visiting the most important fruit-growing sections. Most of his work was in the orchards, where the actual mischief done by the birds was noted and specimens were collected. Besides those secured by him, a great many stomachs have been received from other collectors in the State, and it is believed that in the case of many species enough material is at hand to show the good and harm done by each, so that the fruit grower may know which kinds to encourage and which to restrain.

In 1903 the University of California, in conjunction with the two great apple-raising counties of Santa Cruz and Monterey, undertook an investigation of the ravages of the codling moth with a view of devising, if possible, some remedy for the immense damage done the apple crop by that insect. The annual product of apples in the Pajaro Valley, where the investigation was carried on, is valued at more than a million dollars, even when the codling moth has unrestricted sway. The inquiry was placed in the hands of a commission under the supervision of Prof. C. W. Woodworth, of the State University, and was carried on by competent assistants. One branch of the work was devoted to ascertaining what restrictive influences, if any, were exercised by birds upon the increase of the moth in any of its stages. In cooperation with the United States Biological Survey, Mr. J. S. Hunter, who had charge of this part of the work, conducted the field studies and sent his bird stomachs to our laboratory for examination. Professor Beal also visited the Pajaro orchards in order to familiarize himself with the local conditions, and since his return has been engaged in examining the contents of these stomachs, together with those obtained by himself and others in various parts of the State. One of the results is the gratifying discovery that the codling moth, in spite of its self-protecting habits, is preyed upon by at least two species of birds. As the adult moths fly only at night, and the larvæ live inside of the apple, it was hardly expected that birds would be able to capture them. But when the larvæ leave the apple they seek crevices in the bark of the trees, or descend to the ground to pupate where they conceal themselves among clods of earth or rubbish. These pupæ, it was found, had been searched out and eaten to a considerable extent by the black-headed grosbeak (*Zamelodia melanocephala*) and Bullock oriole (*Icterus bullocki*), two of the handsomest and commonest song birds of California.

As complaint has been made that birds destroy honeybees, a large number of bee keepers were interviewed, especially in southern California, and much information on this point was obtained. It was found, however, that such ravages are special rather than general, and the majority of bee keepers had no complaint to make. Stands of bees placed in lonely canyons where birds are abundant are sometimes visited by them to such an extent as to cause the inference that the bees are being preyed upon. Further investigation, however, has cast some doubt on the supposed injury done by birds; for the examination of stomachs of birds shot near beehives almost always shows that if bees are eaten at all the ones selected are the males or drones. Recently about a hundred stomachs of cliff swallows (*Petrochelidon lunifrons*) were examined, of which a large proportion contained honeybees—some as many as eight individuals—but in no instance was a worker bee found, the birds having eaten only the drones. Since swallows take their food on the wing, this seems to demonstrate that they easily distinguish the drones from the workers in mid-air and take the former by preference.

Some interesting preliminary observations were made as to the damage done by seed-eating birds to the great seed farms of California, but this subject requires further investigation.

In continuation of the studies of the food habits of game birds, Dr. Sylvester D. Judd has given special attention to the quail, particularly during the winter, to ascertain where the birds live and what they eat during the inclement season. The careful and detailed study of this bird has demonstrated beyond question that from an economic point of view the quail is one of the most valuable of North American birds. Examination of the contents of large numbers of crops and stomachs has revealed the important fact that throughout its broad range it feeds largely on some of the worst insect pests known to agriculture. Among the important insects eaten are the cotton boll weevil, potato bug, chinch bug, wireworm, cutworms of various kinds, and the cotton bollworm. Besides destroying multitudes of these pernicious insects the quail devours very large quantities of seeds of noxious weeds; and since much of its time is spent in cultivated fields the value of its services to the farmer can hardly be exaggerated.

BIRD MIGRATION.

During the year the usual spring and fall migration schedules were sent to and received from the regular observers and filed for future use. Sixteen thousand notes relating to the migration of warblers north of the Ohio and Potomac rivers, to complete a bulletin on North American warblers, were selected and arranged for publication.

With a view to determining more accurately the location of the principal routes taken by migratory birds, a circular was issued requesting data on the arrival and departure of five common species—the nighthawk, catbird, kingbird, red-eyed vireo, and redstart. Copies of this circular were distributed to a large number of observers, and it is hoped that important information may be received, especially from localities hitherto unrepresented. Work was commenced on a study of the relations of migration and the weather by comparing the time of spring arrivals with the temperature at the place of arrival and in the region to the southward.

SECTION OF GAME PROTECTION.

In the section of game protection, in charge of Dr. T. S. Palmer, considerable attention has been directed to the work of organization, and the office is now much better equipped than formerly to meet the various demands made upon it. Current work has been kept up to date and several special investigations have been pushed to partial or entire completion. As heretofore, work has been conducted on four well-marked lines: (1) Supervision of the importation of foreign birds and mammals; (2) cooperation in restricting interstate shipments of game contrary to law; (3) protection of game in Alaska, and (4) collection and publication of matter relating to game protection.

IMPORTATION OF FOREIGN MAMMALS AND BIRDS.

During the year 318 permits were issued for the entry of 1,470 mammals, 205,400 canaries, and 41,630 miscellaneous birds,[a] and 9 for the entry of 2,858 eggs of partridges and pheasants,[b] as compared with 383 permits issued during 1903 for the entry of 629 mammals, 201,527 canaries, and 53,106 miscellaneous birds, and 4 for the entry of 2,000 eggs of pheasants and partridges. Of the 327 consignments entered in 1904, inspection was made of 99 at the port of New York, as compared with 103 the previous year. The record of the past year shows an appreciable decrease both in the number of permits and in the number of miscellaneous birds imported thereunder.

The decrease in the number of birds is due to several factors, among which may be mentioned enforcement of the law against possession of Chinese quail in California, and requirement by the Treasury Department of what is known as "owner's oath." In January the board of fish commissioners of California took active steps to enforce the quail law, and importations of Chinese quail practically ceased, with the result that the total number received this year was only 5,120, as compared with 7,450 in 1903. Under the requirement of "owner's oath" the owner of imported goods actually purchased must declare them before a customs notary or a notary public designated by the Secretary of the Treasury. The difficulty of complying with this requirement necessitated the cancellation of a number of orders for pheasants from Canada. The main cause of the difference between the figures of this year and those of previous years, however, particularly in the case of cage birds, is the fact that those of 1904 show the number of actual entries, as nearly as possible, instead of being based on the numbers shown by the applications for permits. Since some birds for which permits are issued are not shipped, or die en route, the figures given this year are smaller than those of last year, though much more accurate. The apparently large increase in mammals is due to the entry of 1,043 guinea pigs. The number of other mammals was 427, as compared with 457 the previous year.

The importations of the year include several entries worthy of note. Among the mammals were 228 squirrels, 52 hedgehogs, 2 echidnas, and several rare marsupials from Australia. Among the game birds

[a] These figures practically exclude parrots, which require no permits, and of which 17,325 were entered during the year, though a few that arrived in miscellaneous shipments and were mentioned in the permits, are here included.

[b] Not including 1 box containing an unknown number of eggs.

were 65 capercailzie imported by the fish and game commission of Ontario for liberation in the Algonquin Park in Ontario. About 40 Mexican quail (*Lophortyx elegans*), obtained near Ures, Sonora, in the latter part of February, 1904, were imported by the board of fish commissioners of California; 10 pairs were liberated in the San Joaquin Valley, 5 at Bakersfield, and 5 near Del Rey, and the remainder were kept in captivity at Sacramento. Among the entries of game birds for exhibition and aviaries were several rare pheasants and a talagala cock (*Megacephalon maleo*).

Although the cage-bird traffic of the United States is small in comparison with that of some foreign countries, notably Germany, nevertheless 35,000 miscellaneous birds other than game birds arrived at various ports during the past year. About one-third of the cage birds imported (10,400) were European species. Of these, 5,000 were goldfinches and 1,200 linnets, both imported in large numbers for breeding with canaries. The remainder comprised 1,350 bullfinches, 900 siskins, 900 skylarks, 600 chaffinches, and 450 miscellaneous birds. A consignment of 366 European birds containing goldfinches, bullfinches, larks, and robins, intended for liberation in British Columbia, was imported at New York in November, 1903. The Orient furnished a variety of species, chiefly Java sparrows, of which 4,750 were imported, and strawberry finches (*Sporæginthus amandava*), of which 1,000 came in. Twenty per cent of the Java sparrows were the white form produced under domestication. Of Australian birds, the most popular seem to be the grass parrakeet, of which 3,400 were brought in, and the cockatoos and the zebra finches, all hardy species in captivity. Aside from parrots comparatively few cage birds are imported from Mexico and South America, but among those received may be mentioned 500 gray cardinals from South America and 120 Mexican solitaires from Vera Cruz. No permits are required for the entry of parrots, the number of which imported, 17,325, shows a considerable trade in these birds. Of the total, 6,993 were entered at El Paso, 6,115 at New York, and 4,020 at San Francisco. A few were also received at Philadelphia, New Orleans, and Pensacola. A small consignment of Madagascar weavers (*Foudia madagascariensis*) which arrived in January, 1904, is of special interest. This is one of the species which should be carefully watched as it has proved very injurious in some regions where it has become acclimated. Since the birds in question are to be kept in captivity, however, no danger is apprehended from their entry. Two lots of miscellaneous birds from Calcutta which arrived at New York in April, 1904, contained certain species of minas, jays, thrushes, magpies, bulbuls, and hunting crows, rarely brought to the United States.

Efforts have been made to improve the service in several respects. An additional inspector at the port of New Orleans was appointed on April 12, 1904, making a total of fourteen. Of these, three are stationed at New York, two each at Boston, Philadelphia, Baltimore, New Orleans, and San Francisco, and one at Honolulu.

So far as known no injurious species have been entered during the year. Two European starlings which, through ignorance of the law, were ordered with a small consignment of other cage birds, were left in England and other birds substituted for them. In May the Bishop Museum in Honolulu received a small consignment of birds from New Zealand, in which were 6 specimens of the kea (*Nestor notabilis*), well

known on account of its alleged habit of attacking sheep. The importation of these birds met with considerable opposition in Honolulu, and soon after their arrival they were killed by order of the trustees of the museum.

INTERSTATE COMMERCE IN GAME.

During the year 10 cases involving the shipment of 700 birds and 36 rabbits were reported to the Department as against 35 cases involving the shipment of 3,729 birds[a] during the preceding year. During the year 6 convictions and several indictments were secured, making a total of 42 convictions in cases passing through the Department since the passage of the Lacey Act in 1900. Of these, 26 convictions were secured in Federal courts and 16 in State courts. One notable conviction, involving the shipment of game from St. Paul, Minn., to Portland, Oreg., was secured during the year. In this case, which was based on the longest shipment thus far taken up under the Lacey Act, it was necessary to bring witnesses from the Pacific coast to St. Paul, Minn. The successful outcome was due not only to the efforts of the United States attorney at St. Paul, but also to cordial cooperation on the part of the State wardens of Minnesota and Oregon. In connection with this phase of the work mention should also be made of the cooperation of the State game commissioner of Illinois and the State game warden of Iowa, both of whom, as in past years, have rendered invaluable service.

Efforts have been made to encourage officials cognizant of violations of the Federal law to present their evidence directly to the nearest United States attorney or United States commissioner instead of referring it through this Department and the Department of Justice, but for some reason State wardens often hesitate to take a case into the Federal courts. Up to the present year little progress was made in this direction, but during the past few months two or three cases have been presented direct to the courts and indictments promptly secured.

As stated in the last annual report, owing to limited resources efforts have been concentrated in two or three areas. Whenever possible, prevention of the illegal shipment of game has been given preference to prosecution of the shippers after shipment has taken place. The enactment of a law in Texas in 1903 prohibiting the sale and export of waterfowl made it possible for the first time to restrict the enormous destruction of ducks for northern markets, which has occurred in that State in recent years. Through local authorities and express companies general attention was called to the provisions of the State and Federal laws, and a close watch maintained on the usual routes of shippers. These efforts were so far successful that, notwithstanding special endeavors to detect unlawful shipments, no exportation of waterfowl from Texas was noted, and it is safe to assume that comparatively few consignments of ducks reached northern markets from the gulf coast of Texas during the year. Similar efforts have been made to restrict illegal shipments of quail and prairie chickens from certain States west of the Mississippi River, and also of quail from North Carolina, but in the last case with only partial success.

[a] Not counting 10 barrels of prairie chickens.

In order to ascertain the results accomplished by recent legislation prohibiting shipment and sale of game, a special investigation was undertaken during the fall in cooperation with State wardens and correspondents in a number of States. Correspondents were asked to ascertain the kinds of game, the sources of supply, and the prices at which game was offered for sale in the markets of a dozen or more important cities during Thanksgiving week. This week was selected since it occurs during the open season in practically all the States and at a time when game is in general demand, so that statistics are more comparable than they would be if collected at different times and under varying conditions.

Owing to unforeseen delays the returns which should have been available before Christmas were not received until too late for use during the open season of 1903, but they will be useful for comparison with similar statistics collected in the future. The investigation showed conclusively that considerable progress was being made in enforcing the shipping laws. For the first time in recent years prairie chickens were almost entirely absent from the markets of Washington, D. C., and very few were on sale in any of the eastern cities. Quail also were unusually scarce in the eastern markets at the opening of the season; but later, when the routes of shipment still open were discovered by the trade, birds were obtained in greater numbers. A marked decrease in the shipment of deer was also noticeable, and venison in the carcass was absent from the markets of several cities where formerly it was abundant. The growing scarcity of game and the stringency of shipping laws have resulted in a remarkable increase in the price of certain game, particularly of prairie chickens. At the opening of the season these birds brought from $12 to $15 per dozen wholesale in Chicago, where a few years ago the regular rate was only one-third or one-fourth these prices.

PROTECTION OF GAME IN ALASKA.

The Alaska game law has accomplished the main objects for which it was enacted, namely, stopping the shipment of hides of deer and curtailing the export of heads of moose and other big game for trophies or commercial purposes. The general feeling in the Territory seems to be in favor of protecting the game, and in a few places an unexpected interest has been taken in the enforcement of the law.

From the standpoint of game protection the law has perhaps been as satisfactory as could have been expected in such a vast region, and without the employment of wardens, yet it has aroused considerable opposition. This appears to be due in part to the unnecessary stringency of certain features of the present statute, and in part to the killing of big game on the Kenai Peninsula by visiting sportsmen, who are attracted by the accessibility and abundance of the white sheep and giant moose. The opposition became so strong that on February 8 a bill was introduced in the Senate to repeal the present law and to substitute merely a provision for the issue of licenses permitting the shipment of a limited number of big game trophies, with fees of $25 for residents and $250 for nonresidents. No definite action was taken on this measure prior to the adjournment of Congress, and as the matter is still pending the Department has deemed it advisable to suspend the issue of permits for the present, except in special cases. During the fiscal year 60 permits were issued for the export

of trophies and scientific specimens, nearly all of which were issued prior to the introduction of the Senate bill. Of these, 5 will probably not be used until next autumn. The remaining 55 were for use within the fiscal year 1904, and as 34 issued during the spring of 1903 were not to be used until after July 1, 1903, 89 export permits in all were in effect during the year. Twelve of these were issued to foreigners, and 77 to citizens of the United States. Many permits were not used, and the actual number of shipments was therefore much smaller than these figures would indicate. Early in June a new set of regulations was issued for the current year, extending such open seasons as experience showed could be lengthened without injury to the game, permitting unrestricted shipment of bear skins, and making other changes that seemed to be necessary to adapt the law to the needs of the Territory.

TRANSFER OF ELK.

An item in the appropriation bill for 1904 providing for the transfer of elk has finally made possible the acceptance of a herd of these animals in Kern County, Cal., offered to the Department several years ago by Miller and Lux. This herd, numbering about 100 animals, has been protected for a number of years by the owners of the ranch. In order to find a locality affording suitable range and adequate protection, an examination was made of the forest reserves in southern California, and a location was selected in Tulare County, on the Middle Fork of Kaweah River, just within the confines of the Sequoia National Park. This range affords both summer and winter feed and abundance of water, and is so situated as to require comparatively little fencing. Through the cooperation of the Secretary of the Interior permission was obtained to utilize this part of the park for a preserve, and to erect the necessary fence. A special wire fence, about 2 miles in length, along the western boundary of the preserve, was completed shortly before the end of the year. Natural barriers inclose all the rest of the tract except a short section on the eastern boundary, which also required fencing. Preparations were made to transfer the elk from their present quarters to the park, a distance of about 80 miles, but the actual transfer has been delayed, owing to the fact that the animals have not been captured and delivered at the railroad.

PELICAN ISLAND RESERVATION.

The warden maintained on Pelican Island Reservation, Florida, by the Biological Survey, in cooperation with the American Ornithologists' Union, has prevented molestation of the pelicans and has reported several facts concerning the habits of the birds not before recorded. The nesting season of 1903 was unusually long, extending from December 1, 1902, to July, 1903, when the birds left the island. Early in November, 1903, they returned and by the 4th were present in considerable numbers. Instead of building on the main island as usual, they nested on two small islands or mud flats near by. The first eggs were laid about December 1 and by the 5th of the month there were fully 150 nests with eggs. The first eggs were hatched about December 24, young covered with down were first noticed on January 13, 1904, and by the middle of March they were able to fly. At the

end of the month there was a notable decrease in the number of pelicans on the reservation, and by May 1 all the birds had left. The season of 1904 was anomalous in several respects. Although the birds returned to the island unusually early, they nested in smaller numbers than in the previous year, and considerable havoc was caused on February 11 and 12 by a hard 'norther,' accompanied by unusually high water, which flooded all the nests built on the ground. Whether this storm was responsible for the early departure is uncertain, and its full effect can not be ascertained until the birds return in the fall of 1904.

INFORMATION CONCERNING GAME PROTECTION.

The constantly increasing demands for information concerning game relate not only to the distribution and habits of native birds and the importation of foreign species, but often raise questions regarding game laws, technical and otherwise. When game bills are under consideration frequent inquiries are made for general information concerning particular features of legislation. Thus, when a search law was pending in Massachusetts last spring, a request was received from that State for a list of all the States having laws authorizing game wardens to search for and seize illegal consignments of game with or without a warrant; and when New York was considering a bill prohibiting spring shooting, several requests were received for statements showing similar legislation in other parts of the Union and Canada.

The Department is sometimes asked to send a representative to meetings of various kinds. When possible, these requests are complied with, in the belief that personal explanation is often the most effective method of disseminating information.

At the request of the National Association of Game Wardens, the preparation of an index of the more important decisions bearing on game laws has been undertaken. More than one hundred such decisions have been collected and are being indexed by title, State, and subject. This index will contain a brief statement of the facts in each case, and the syllabus, so as to show at a glance what points in game laws have been passed on by the higher courts in each State.

SPECIAL INVESTIGATIONS.

In addition to the investigations already referred to, special studies were made of several subjects connected with game protection, among the most important being that of game commissions and the enforcement of game laws. This work, which was begun two years ago, is now almost completed. The bulletin in which the results will appear will consist of a historical introduction, a statement of the protective work of each State, and abstracts of the laws relating to State game officials, its object being to show how game laws are enforced, a question concerning which many inquiries are received. Tables have been prepared showing the special officers charged with enforcement of game laws, their terms of service, duties, and powers, and the sources and distribution of funds for game protection. In connection with this work a personal examination has been made of the methods adopted by the commissions and wardens of New York, North Carolina, Maryland, West Virginia, Ohio, Illinois, Minnesota, Washington, Oregon, and California.

An inquiry from the fish and game commission of Ohio relating to the form of statement of seasons for game led to an investigation of the forms and interpretations of such statements, and to the preparation of a circular calling attention to the uncertainty and lack of uniformity in the forms in use, the trend of judicial decisions bearing on the subject, and the most available remedy for the evil.

A special report has been prepared outlining the history and development of the hunting license system in the United States—a subject attracting considerable attention, owing to the fact that in certain States licenses have become the chief source of income for game protection.

ROUTINE WORK.

During the year 1903–4 the routine work steadily increased. This consists of correspondence, accounts of expenditures, preparation of reports and bulletins for publication, identifying and labeling specimens, care of collections, cataloguing bird stomachs received, tabulating field reports, sorting and filing published matter valuable for reference, mapping distribution of birds and mammals, attention to the needs of field naturalists, developing photographic negatives and making prints therefrom, compiling game laws, issuing permits for the entry of foreign mammals and birds and for the export of trophies and specimens from Alaska, and cooperation in enforcing the various provisions of the act of Congress of May 25, 1900. The letters received during the year numbered about 5,000. Many of these were accompanied by schedules or reports; others contained other material also of permanent value. During the same period about 4,000 letters were written and 900 blank migration and other schedules distributed to observers. The collection of photographic negatives made by the members of the Biological Survey while in the field now numbers over 7,200, and is of constantly increasing value for purposes of study and illustration.

PUBLICATIONS.

The publications issued during the year include one number of North American Fauna, two articles in the Yearbook for 1903, four circulars, the report of the Chief for 1903, three Farmers' Bulletins, two large posters showing the close seasons for game, and 20 reprints of former publications. North American Fauna No. 23, by T. S. Palmer, comprises "A list of the genera and families of mammals." The Yearbook articles are entitled, "The economic value of the bobwhite," by Sylvester D. Judd, and "Some new facts about the migration of birds," by Wells W. Cooke. The circulars are as follows: No. 39, "Regulations for the protection of game in Alaska;" No. 40, "Directory of State game officials and organizations concerned with the protection of birds and game, 1903;" No. 41, "Migration of birds," and No. 42, "Regulations for the protection of game in Alaska for 1904." Farmers' Bulletin No. 54, "Some common birds in their relation to agriculture," by F. E. L. Beal, was rewritten and much material added on the food of western birds. The other Farmers' Bulletins published were: No. 180, "Game Laws for 1903," and No. 197, "Importation of game birds and eggs for propagation." The two posters showing the close seasons for game were prepared especially for display in railroad and express offices and other suitable places of business.

The reprints include North American Fauna No. 22, "A biological investigation of the Hudson Bay region," by E. A. Preble; Bulletin No. 17, "Birds of a Maryland farm," by Sylvester D. Judd; the annual report of the Chief for 1903; five circulars (Nos. 17, 29, 39, 40, and 42), six Yearbook articles, and two Farmers' Bulletins (Nos. 54 and 180). In the case of Farmers' Bulletin No. 54, "Some common birds in relation to agriculture," 360,000 copies have been issued since the date of the original publication. Of Farmers' Bulletin No. 180, "Game laws for 1903," a reprint of 15,000 copies was required to meet the demand, making a total of 45,000 issued.

The titles of the Yearbook articles reprinted are as follows: "Four common birds," 1895 (two issues); "Meadow lark and Baltimore oriole," 1895 (two issues); "Blue jay and its food," 1896 (two issues); "Birds as weed destroyers," 1898; "Food of nestling birds," 1900; "Audubon societies in relation to the farmer," 1902.

OUTLINE OF WORK FOR THE YEAR 1905.

GEOGRAPHIC DISTRIBUTION.

Field work in California will be continued during the year 1904–5, though owing to shortage of funds it will not be practicable to do as much as was planned. Work is outlined for the Sacramento Valley and the foothill slopes of the Sierra, and it is hoped that the region drained by Feather River and its tributaries may receive attention, and possibly also the southern Sierra between Kern Valley and Tehachapi.

In Texas the bulk of the field work has been completed, but some areas still remain to be visited before the final report is published.

In New Mexico field work will be conducted by two parties in the northern counties and will be extended into southern Colorado.

Explorations in Alaska are in progress, and, in cooperation with Charles Sheldon, of New York, the northern spurs of the Rocky Mountains about the upper and middle Yukon and adjacent Canadian territory will be visited at trifling expense to the Biological Survey.

It is expected that the biological reconnoissance of the Mackenzie Basin will be completed and that a general report will be prepared, including the regions about Great Slave Lake and Athabasca River.

ECONOMIC ORNITHOLOGY AND MAMMALOGY.

The investigation of the food of California birds will be continued, as will be also work on special bulletins relating to the food of groups of birds of economic importance. The data obtained from the examination of California stomachs add materially to the value of these bulletins, since exact information concerning the food of western birds has never before been obtained.

In Texas field work will be conducted in the cotton belt in cooperation with the Bureau of Entomology to determine what influence birds exert in controlling the abundance of the cotton boll weevil. It is expected that information will be secured that will prove of value in connection with the efforts of the Department to discover means of limiting the damage done by this insect.

Studies of the food habits of game birds are in great demand, and are being pushed as rapidly as practicable. The first results, so far as

they relate to the quail and grouse, are now ready for publication, and others will follow.

The food supplied nestling birds by their parents is a subject worthy of careful study and will receive as much attention as possible. Observations already made indicate that the quantity of food consumed by nestlings is enormous, and since in many species such food consists largely or wholly of insects, it has a definite economic importance. Some birds occasionally do harm, but experience shows that instances of damage are usually caused by conditions for which a remedy can be found. On the other hand, birds that never do harm and feed constantly on insects can be encouraged to nest and remain about the farm. Boxes may be placed for the useful martins, wrens, blue birds, and swallows. Small investments of this kind not only make country life more attractive, but pay the farmer liberal dividends in the way of increased crops. Public sentiment in relation to birds is slowly changing for the better, and there is no question that by the judicious protection and encouragement of the most useful species much good will result.

In past years the Biological Survey has published special papers on the economic status of certain noxious mammals and the best means of combating their depredations. The jack-rabbits, prairie dogs, pocket gophers, and Mississippi Valley ground squirrels have been thus discussed. This work will be continued. Among the animals to be taken up in the near future are the field mice and the coyotes and large wolves, groups which are highly destructive over large areas of our country. During the winter of 1903–4 hundreds of thousands of fruit trees were ruined by the gnawings of the thickset short-tailed meadow and woods mice of the genus *Microtus*, and at the present time the success of the sheep industry is in some sections seriously handicapped by the incessant inroads of the coyote. It is believed that in both cases means may be found which will materially lessen the magnitude of the losses from these sources.

GAME PROTECTION.

Plans for the coming year contemplate the continuation of work along the main lines already begun, and such special investigations and studies as means at hand will permit.

IMPORTATION OF FOREIGN SPECIES.

The trade in foreign cage birds has furnished a mass of data derived from applications for permits, inspection reports, and miscellaneous notes, of interest from both economic and ornithological standpoints. Some of these data will be prepared for publication during the year.

INTERSTATE COMMERCE IN GAME.

Work under this head will include investigation of the sources of supply for eastern markets, methods of handling game, and devices adopted to evade the shipping provisions of State and Federal laws. Efforts will be concentrated in regions which, by reason of local conditions or special cooperation on the part of State officers, seem to offer the best opportunity for effective action.

PUBLICATIONS ON GAME PROTECTION.

The report on game commissions and methods of enforcing game laws will be completed. The bulletin on the migration and protection of shore birds; a summary of the game laws for 1904 relating to seasons, sale, shipment, and licenses; and a directory of game officials and organizations will be issued during the year. And if practicable, the compilation of laws concerning nongame birds, published as Bulletin 12, will be revised and brought down to date.

INFORMATION CONCERNING GAME LAWS.

Under the provisions of the act of May 25, 1900, the work of the Department relating to game protection must be carried on "subject to the laws of the various States and Territories." Full knowledge of the laws, which is essential in order to conduct the work successfully and to answer many of the inquiries received, involves familiarity with the general literature of game legislation. This literature is widely scattered and may be divided into three main classes: (1) Statutes, found in the session laws and revised statutes of the various States; (2) interpretation of the laws by the higher courts, found in the official reports; and (3) a great mass of publications neither legislative nor judicial, consisting of special treatises, discussions and papers, and less formal notes. Much of the matter in this last class is published in current periodicals, poorly indexed and difficult of access, but some of it is very valuable in throwing light on special questions of precedent or procedure. It is proposed to issue publications covering these three classes somewhat as follows: (1) Periodical bulletins on game laws and legislation affecting nongame birds, and a special bulletin on game commissions; (2) an index and abstract of the more important decisions of the courts involving the construction of game laws; and (3) a bibliography of the general literature of the subject.

SPECIAL INVESTIGATIONS.

Among the special investigations which it is desirable to take up as soon as means permit is one concerning game preserves. This involves the determination of the number, area, location, and character of the holdings now owned or leased by corporations or individuals for the preservation of game. Private game preserves have increased greatly in number during the past decade, and their value is becoming more and more generally recognized.

The extent to which birds are killed by cold winters should be investigated, with a view to the discovery of means by which such destruction may be lessened. The severe winter of 1903–4 proved very disastrous to quail in the northern part of their range. In Maryland, and possibly elsewhere, experiments in feeding quail during severe weather seemed to meet with marked success.

Three requests have been received during the past year for cooperative work or for the preparation of special publications which merit special consideration, both on account of the sources from which they come and because they are directly in line with the work of game protection.

(1) A request was received from the chairman of the senate committee on fisheries and game of the New York legislature for a publi-

cation on the protection of wild fowl with special reference to spring shooting. This subject has already engaged the attention of the office, and some data have been accumulated. Before the request can be complied with, however, more facts must be acquired and some special studies undertaken.

(2) The New York State Library is undertaking a comprehensive index of legislation and has requested the cooperation of the Biological Survey in preparing an index of the State laws relating to game. The want of such a convenience is constantly apparent, and such an index would prove of the greatest utility not only in the routine work of the office, but also to persons who have occasion to know what laws States have passed covering certain features of game protection.

(3) From Brazil comes a request for a bulletin on legislation for the protection of nongame birds in the countries of Central and South America and the West Indies on the same lines as the bulletin already issued for the United States and Canada. In view of the large number of our birds which pass the winter in the West Indies and South America, the value of such a publication can be readily understood. The demand for a work of this kind, both in this country and abroad, is indicated by the fact that during the past year the Mexican Government has translated the main part of Bulletin No. 12, "Legislation for the Protection of Birds Other than Game Birds," into Spanish and issued it as a bulletin of its Secretaría de Fomento.

RECOMMENDATIONS.

The Biological Survey is charged by Congress with three distinct lines of work, each of coordinate value with the ordinary departmental division. These are: (1) Section of geographic distribution; (2) section of economic ornithology; (3) section of game protection.

In submitting estimates for the fiscal year 1906 the following recommendations are respectfully made:

(1) That the Biological Survey be recognized as a bureau, with the three sections as separate divisions.

(2) That an increase of $4,850 in the statutory roll be granted to enable the Secretary to reorganize the Biological Survey as a bureau of the Department.

(3) That an increase of $5,000 in the lump fund be granted to provide for the greatly increased demands for information and field work on geographic distribution, economic ornithology, and game preservation, and to enable the Survey to retain the services of trained assistants.

REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ACCOUNTS AND DISBURSEMENTS,
Washington, D. C., October 4, 1904.

SIR: I have the honor to submit herewith a report of the work of the Division of Accounts and Disbursements for the fiscal year ended June 30, 1904.

Very respectfully,

F. L. EVANS, *Chief of Division.*

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

APPROPRIATIONS, EXPENDITURES, ETC.

The total sum appropriated for the year ended June 30, 1904, was $5,258,160, as shown in detail in the following financial statement, in which also appear the disbursements and unexpended balances July 1, 1904. Nine-tenths of the total unexpended balance is covered by liabilities and will be settled in the form of supplemental accounts. The usual sum of $720,000 was appropriated for the forty-eight agricultural experiment stations in the several States.

Appropriations, disbursements, and amount unexpended for the fiscal year 1904.

Object.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$471,080	$457,451.19	$13,628.81
Bureau of Animal Industry:			
General expenses	1,200,000	1,123,471.36	76,528.64
To eradicate contagious diseases of animals, 1904–5	250,000	110,237.23	139,762.77
Bureau of Plant Industry:			
Vegetable pathological investigations	130,000	112,109.59	17,890.41
Pomological investigations	37,000	32,370.05	4,629.95
Botanical investigations and experiments	65,000	56,806.45	8,193.55
Grass and forage plant investigations	35,000	31,555.27	3,444.73
Experimental gardens and grounds	25,000	24,721.81	278.19
Arlington Experimental Farm	15,000	14,750.23	249.77
Tea-culture investigations	10,000	7,161.10	2,838.90
Purchase and distribution of valuable seeds	290,000	256,306.12	33,693.88
Investigating production of domestic sugar	5,000	3,571.96	1,428.04
Cotton boll weevil investigations, 1904–5	250,000	40,935.89	209,064.11
Bureau of Forestry; Forestry investigations	312,080	278,762.07	34,317.93

Appropriations, disbursements, and amount unexpended for the fiscal year 1904—Cont'd.

Object.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Bureau of Chemistry: Laboratory	$70,500	$68,402.29	$2,097.71
Bureau of Soils: Soil investigations	170,000	149,094.57	20,905.43
Entomological investigations	65,500	56,861.39	8,638.61
Biological investigations	34,000	29,563.94	4,436.06
Publications, Department of Agriculture	200,000	188,290.15	11,709.85
Collecting agricultural statistics	109,200	104,941.19	4,258.81
Foreign-market investigations	7,500	7,261.47	238.53
Library	10,000	8,365.46	1,634.54
Contingent expenses	37,000	35,194.83	1,805.17
Agricultural experiment stations ($810,000) [a]	90,000	87,617.12	2,382.88
Nutrition investigations	20,000	17,161.49	2,838.51
Irrigation investigations	65,000	51,603.96	13,396.04
Public road inquiries	35,000	33,970.06	1,029.94
Total	4,009,640	3,388,538.24	621,101.76
WEATHER BUREAU.			
Salaries	175,440	175,098.94	341.06
Fuel, lights, and repairs	6,000	5,730.46	269.54
Contingent expenses	8,000	6,805.70	1,194.30
General expenses	969,080	836,518.67	132,561.33
Buildings	50,000	36,628.56	13,371.44
Cables and land lines	40,000	40,000.00	.....
Total, Weather Bureau	1,248,520	1,100,782.33	147,737.67
Grand total	5,258,160	4,489,320.57	768,839.43

[a] Of this amount, $720,000 is paid directly to the experiment stations from the Treasury Department.

There were received, audited, and paid 35,646 accounts, as follows: Weather Bureau, 10,008, amounting to $1,320,562.46; Bureau of Animal Industry, 6,817, amounting to $1,362,891.09; all other Bureaus and Divisions, 18,821, amounting to $2,339,122.80—a total of $5,022,576.35. In payment of these accounts 43,937 checks were drawn on the Treasury at Washington and subtreasuries at New York and Chicago.

REQUISITIONS, LETTERS, REQUESTS, CONTRACTS, AND LEASES.

There were 165 requisitions drawn on the Treasury, aggregating in amount $6,086,154.73.

The number of requisitions issued for supplies was 13,977.

The number of letters of authorization for travel was 1,882.

The number of letters written and received in the ordinary transaction of business was 65,098.

The number of requests for passenger transportation was 6,237.

The number of requests on the Quartermaster-General for the transportation of Government property was 2,578.

The number of leases and agreements executed and in effect was 359.

The number of contracts for supplies, etc., was 168.

The amount expended for telegraphing and telephoning by the Weather Bureau, including the West Indian cable service, was $203,421.17.

MONTHLY CHECK STATEMENTS, SETTLEMENT OF ACCOUNTS, ETC.

The check statements submitted monthly by the Treasury and subtreasuries for verification were checked up and found to agree with the records in this office. The annual report to Congress of all expend-

itures of the Department for the year 1903 was prepared in this office and submitted through the Speaker of the House of Representatives, in conformity to a law which affects only this Department.

PUBLIC MONEYS RECEIVED FROM VARIOUS SOURCES.

There were received from various sources and deposited in the Treasury to the credit of the proper funds the following sums:

Sales of condemned property	$4,392.46
Sales of card index	247.07
Sales of publications, Weather Bureau	625.24
Telegraph line receipts, Weather Bureau	2,337.33
Sales of American products in Europe	2,752.99
Sales of products, agricultural station, Hawaii	308.17
Sales of products, agricultural station, Porto Rico	338.87
Sales of products, agricultural station, Alaska	102.75
Sales of experimental shipments of fruits to Europe	217.70
Total	11,322.58

ANNUAL SUPPLIES.

Contracts were made in the usual manner for annual supplies needed during the year by the several branches of the Department, aggregating in value $217,697.89.

TELEPHONE SERVICE.

Pending a decision by the superior court of the District of Columbia, the Department made no contract with the Chesapeake and Potomac Telephone Company last year, but accepted service at the rates fixed by the Comptroller of the Treasury, based upon the law of June 30, 1898.

The interior system belonging to, maintained, and operated by the Department worked most satisfactorily and economically during the year—the second year the system has been in operation. The total expense for repairs was $1.30—an evidence of the perfection of the plant. Sixteen additional telephones were placed on the system, thus increasing the number to 60, the present wired capacity of the switch board. Because of the great demand for a further extension of the system from the various Bureaus of the Department, the fact that it represents a large saving in messenger service, and is a speedy and more satisfactory means of communication, it is strongly recommended that the switch board be wired to its full capacity—100 telephones.

ACCOUNTS FOR THE FISCAL YEAR 1902 FINALLY CLOSED.

The unexpended balances of the appropriations for the year 1902, amounting to $20,008.39, were finally covered into the Treasury on June 30, 1904, and carried to the surplus fund, as shown on the next page.

Amount of unexpended balances turned into the Treasury.

Object.	Amount appropriated for 1902.	Amount disbursed.	Amount unexpended.
Salaries	$373,820.00	$370,039.69	$3,780.31
Library	7,000.00	6,754.06	245.94
Contingent expenses	37,000.00	34,543.24	2,456.76
Animal quarantine stations	25,000.00	24,814.88	185.12
Collecting agricultural statistics	120,000.00	117,060.06	2,939.94
Botanical investigations and experiments	45,000.00	44,950.93	49.07
Entomological investigations	28,513.18	27,069.77	1,443.41
Vegetable pathological investigations	60,000.00	59,999.45	.55
Biological investigations	20,000.00	19,807.80	192.20
Pomological investigations	20,000.00	19,985.14	14.86
Laboratory	24,500.00	24,417.47	82.53
Forestry investigations	146,280.00	145,809.76	470.24
Experimental gardens and grounds	20,000.00	19,725.80	274.20
Soil investigations	91,000.00	89,987.21	1,012.79
Grass and forage-plant investigations	20,000.00	19,566.91	433.09
Irrigation investigations	50,000.00	49,980.86	19.14
Agricultural experiment stations ($789,000) [a]	[b] 69,157.05	69,052.71	104.34
Nutrition investigations	20,000.00	19,951.48	48.52
Arlington experimental farm	10,000.00	9,897.16	102.84
Plans for building Department of Agriculture, 1901–2	5,000.00	5,000.00	.....
Public road inquiries	20,000.00	19,957.01	42.99
Publications	188,000.00	187,657.52	342.48
Purchase and distribution of valuable seeds	270,000.00	266,614.22	3,385.78
Investigating production of domestic sugar	5,000.00	4,346.31	653.69
Tea-culture investigations	7,000.00	6,816.25	183.75
Bureau of Animal Industry	1,092,190.28	1,092,100.94	89.34
Total	2,774,460.51	2,755,906.63	18,553.88
WEATHER BUREAU.			
Salaries	159,820.00	159,769.41	50.59
Fuel, lights, and repairs	9,000.00	8,919.71	80.29
Contingent expenses	8,000.00	7,942.81	57.19
General expenses	865,500.00	864,490.74	1,009.26
Meteorological observation stations	60,000.00	59,646.49	353.51
Buildings	46,000.00	46,000.00	.....
Total, Weather Bureau	1,148,320.00	1,146,769.16	1,550.84
Grand total	3,922,780.51	3,902,675.79	20,104.72

[a] Of this amount, $720,000 was paid directly to the experiment stations from the Treasury Department.
[b] Including $157.05 received from sales of card index.

BUILDINGS UNDER LEASE IN THE DISTRICT OF COLUMBIA, WITH ANNUAL RENTAL.

The amount appropriated for rental for the several branches of the Department in the District of Columbia for 1905 is $39,820, against $27,900 for 1904, an increase of $11,920, as follows:

Bureaus and Divisions.	1904.	1905.
Bureau of Chemistry, laboratories and offices, 200–202 Fourteenth street SW	$2,500	$2,800
Bureau of Animal Industry, laboratories and offices, 1362 B street SW	1,800	1,800
Bureau of Soils, laboratories and offices, 212–214 Thirteenth street SW	2,000	6,000
Bureau of Forestry, offices, Atlantic Building, 930 F street NW	10,000	15,500
Bureau of Plant Industry:		
Vegetable pathology and physiology, laboratories and offices, 1306 B street	3,000	3,000
Botanical investigations, laboratories and offices, 224 Twelfth street SW	3,000	3,000
Purchase and distribution of valuable seeds, warerooms, Thirteen-and-a-half street SW	3,000	.....
Grass and forage plant investigations, offices, 1316 B street SW	1,200	2,000
Division of Publications, document rooms, 1304 B street SW	1,400	5,000
Bureau of Entomology, offices, 904 B street SW	.....	720
Total	27,900	39,820

WEATHER BUREAU BUILDINGS.

Buildings completed during the fiscal year.

Location.	Cost of lot.	Cost of building.	Total cost.
Yellowstone Park, Wyo	(a)	$11,500	$11,500
Duluth, Minn	$2,100	7,900	10,000
Devils Lake, N. Dak	2,300	8,000	10,300
Havre, Mont	1,850	5,700	7,550
Mount Weather, Va.: Power house and balloon shed	650	10,000	10,650
Block Island, R. I	1,100	7,700	8,800
Narragansett Pier, R. I	4,100	8,000	12,100
Total	12,100	58,800	70,900

a Government reservation.

Buildings in course of construction, and approximate cost of each.

Location.	Cost of lot.	Cost of building.	Total cost.
Columbia, S. C	$3,799.00	$9,170.00	$12,969.00
Peoria, Ill	54.00	7,915.00	7,969.00
Nantucket, Mass	1,236.50	3,968.00	5,204.50
Mount Weather, Va. (3 buildings):			
Absolute building	(a)	6,500.00	6,500.00
Variation building	(a)	8,000.00	8,000.00
Kite building	(a)	3,000.00	3,000.00
Total	5,089.50	38,553.00	43,642.50

a Government reservation.

Buildings owned by the Weather Bureau.

Location.	Value of lot.	Value of buildings.	Total value.
Amarillo, Tex	$1,255.00	$6,503.00	$7,758.00
Atlantic City, N. J	(a)	6,000.00	6,000.00
Bismarck, N. Dak	(a)	10,000.00	10,000.00
Block Island, R. I	1,100.00	7,700.00	8,800.00
Cape Henry, Va	(a)	9,104.25	9,104.25
Columbia, S. C	3,799.00	9,170.00	12,969.00
Devils Lake, N. Dak	2,300.00	8,000.00	10,300.00
Duluth, Minn	2,100.00	7,900.00	10,000.00
Hatteras, N. C	125.00	4,875.00	5,000.00
Havre, Mont	1,850.00	5,700.00	7,550.00
Jupiter, Fla	(a)	6,094.95	6,094.95
Key West, Fla	2,020.00	7,994.75	10,014.75
Kitty Hawk, N. C	(a)	1,616.00	1,616.00
Modena, Utah	(a)	4,346.00	4,346.00
Mount Weather, Va.:			
Observatory building	2,000.00	18,000.00	20,000.00
Power house and balloon building	650.00	10,000.00	10,650.00
Stable		2,000.00	2,000.00
Mount Washington, N. H	(b)	300.00	300.00
Nantucket, Mass	1,236.50	3,968.00	5,204.50
Narragansett Pier, R. I	100.00	8,000.00	12,100.00
North Head, Wash	(a)	4,000.00	4,000.00
Peoria, Ill	54.00	7,915.00	7,969.00
Point Reyes Light, Cal	(a)	3,000.00	3,000.00
Port Crescent, Wash	82.00	1,000.00	1,082.00
Sand Key, Fla	(a)	5,593.00	5,593.00
Sault Ste. Marie, Mich	(a)	3,000.00	3,000.00
Southeast Farallon, Cal	(a)	5,211.22	5,211.22
Tatoosh Island, Wash	(a)	5,000.00	5,000.00
Washington, D. C	25,000.00	150,000.00	175,000.00
Yellowstone Park, Wyo	(a)	11,500.00	11,500.00
Yuma, Ariz	(a)	1,500.00	1,500.00
Total	47,671.50	334,991.17	382,662.67

a Government reservation. b Leased.

List of cottages occupied as offices and living quarters by the Weather Bureau.

Station.	Annual rent.	Other items included.
Cape May, N. J.	$650	Heat, cleaner, light.
Durango, Colo.	440	Heat, cleaner, water.
Flagstaff, Ariz.	360	
Lewiston, Idaho	540	
Williston, N. Dak.	450	Heat, cleaner, light, and water.
Winnemucca, Nev.	360	Heat, light, water.
Helena, Mont.	504	Heat, water.
Santa Fe, N. Mex.	360	
Charles City, Iowa	420	Heat, light, water.
Roswell, N. Mex.	720	Heat, cleaner, light.

List of stations at which living quarters are separate from office quarters, and cost of each.

Station.	Annual rent.	
	Office.	Residence.
Habana, Cuba	(a)	$300
Honolulu, Hawaii	$480	540

a Public.

The erection of buildings by the Weather Bureau not only saves the amount previously paid for rent of office quarters, but it is adding very much to the prestige of the service here and abroad. This prestige will be increased upon the completion of the group of observatory buildings at Mount Weather, Va., at which place it is intended to conduct experimental and research work along all scientific lines.

ESTIMATES OF APPROPRIATIONS.

The estimates of appropriations for the year ending June 30, 1905, were prepared in this office, as usual, and submitted to the Secretary of the Treasury in accordance with statutory requirement. They amount to $6,729,880, or $67,840 more than the amount appropriated for the present year, shown in detail in the following table:

Appropriations and estimates for 1905.

Object.	Amount appropriated for 1905.	Amount estimated for 1905.
Salaries	$482,600	$495,580
Bureau of Animal Industry:		
General expenses	1,275,000	1,350,000
To eradicate contagious diseases of animals, 1904-5	250,000	500,000
Bureau of Plant Industry:		
Vegetable pathological investigations	150,000	165,000
Pomological investigations	44,500	47,000
Botanical investigations and experiments	67,700	70,000
Grass and forage plant investigations	42,500	46,000
Experimental gardens and grounds	25,000	30,000
Greenhouses, 1904-5	25,000	.....
Arlington Experimental Farm	20,000	25,000
Tea-culture investigations	10,000	10,000
Purchase and distribution of valuable seeds	290,000	290,000
Investigating production of domestic sugar	7,500	5,000
Bureau of Forestry:		
Forestry investigations	388,000	412,860
Testing timbers, Louisiana Purchase Exposition, St. Louis, Mo. (deficiency act)	10,000	.....
Bureau of Chemistry	135,000	148,760
Bureau of Soils, soil investigations	170,000	208,280

Appropriations and estimates for 1905—Continued.

Object.	Amount appropriated for 1905.	Amount estimated for, 1905.
Entomological investigations	$70,000	$90,000
Cotton boll weevil investigations, 1904-5	250,000	.....
Biological investigations	34,000	50,000
Publications	210,000	210,000
Collecting agricultural statistics	139,500	139,500
Library	10,000	12,500
Contingent expenses	37,000	37,000
Agricultural experiment stations ($30,000)[a]	90,000	90,000
Nutrition investigations	20,000	20,000
Irrigation investigations	67,500	70,000
Public road inquiries	35,000	65,000
Building	250,000	.....
Total	4,604,360	4,581,370
WEATHER BUREAU.		
Salaries	180,440	197,430
Fuel, lights, and repairs	8,000	9,000
Contingent expenses	10,000	11,000
General expenses	1,064,300	1,144,080
Buildings	48,000	50,000
Cables and land lines	27,000	27,000
Total, Weather Bureau	1,337,740	1,428,510
Grand total	5,942,040	6,009,880

[a] Of this amount, $720,000 was paid directly to the experiment stations from the Treasury Department.

IMMEDIATELY AVAILABLE APPROPRIATIONS.

The following amounts were made immediately available for 1905:

Greenhouses	$25,000
Vegetable pathological investigations	2,000
Laboratory	15,000
Biological investigations	1,000
Publications	1,000

INCREASE IN SALARIES.

An increase in the salaries of the following officers of the Department was made by Congress, to take effect July 1, 1904:

Chief, Bureau of Animal Industry	from	$4,500	to $5,000
Chief, Bureau of Plant Industry	do	4,000	to 4,500
Chief, Bureau of Entomology	do	2,750	to 3,250

An increase in the salaries of the Disbursing Officer and his first assistant was especially recommended by the Secretary in his estimates for 1905, but failed to receive favorable action by Congress.

LAW CLERK.

The position of law clerk, with a salary of $2,500, was created by Congress, to take effect July 1, 1904. This position had been estimated for and strongly recommended at various times, but failed to receive favorable consideration until the last session of Congress. The position had become entirely essential in the general economy of the Department. Mr. George P. McCabe, of Utah, was appointed to the position.

CONDITION OF WORK IN DIVISION.

No part of the work is now in arrears, although the volume of work has greatly increased, and the clerical force of the Division is severely overtaxed. Every addition to the appropriations correspondingly increases the work in the Division of Accounts and Disbursements. The appropriations have grown in the last five years 60 per cent. The regular clerks of the Division are experienced, capable, and faithful, but they will be unable to handle this increased amount of work without additional competent assistance. The clerks on detail here from other Divisions are not sufficient. It is urgently recommended, therefore, that at least three additional clerkships be estimated for on the roll of this Division for the ensuing year.

REPORT OF THE APPOINTMENT CLERK.

U. S. Department of Agriculture,
Office of the Appointment Clerk,
Washington, D. C., October 3, 1904.

Sir: I have the honor to submit herewith my annual report respecting the officers, employees, and general working force, constituting the effective working body of the U. S. Department of Agriculture, as it existed on July 1, 1904, and also various addenda relating to the classified civil-service appointments, etc.

Very respectfully,

J. B. Bennett,
Appointment Clerk.

Hon. James Wilson, *Secretary.*

INTRODUCTION.

The continued extension and development of the Department of Agriculture in all its various fields of effort calling forth educated and trained specialists in a great variety of scientific lines, and the consequent increase in trained and well-qualified assistants of business capacity for clerical help, as well as various kinds of skilled workmen with their necessary helpers, suggest the propriety of properly placing before you certain details, showing the composition of the force of the Department at this time in the various Offices, Bureaus, and Divisions. The force numbers altogether 4,504 on the pay rolls of the Department, exclusive of a force of subsidiary assistants, correspondents, etc., numbering 229,781, serving voluntarily; and the record affords a fair indication of the variety and scope of work and of the growth of the Department.

I include also a statement of the first classification of the officers and employees of the Department in the classified civil service and the various extensions of the classified service in the Department from that date to the present time.

The special examinations held by the U. S. Civil Service Commission during the past fiscal year for service in the Department of Agriculture are also specified and will be found of interest, especially to students in agricultural and other technical schools and colleges.

The regulations governing officers and employees and their appointment in the Department are also stated.

A compilation of extracts from appropriation acts, 1838 to 1862, showing the amounts given by the United States Government in those years for the promotion of agriculture, has been very carefully made

and will be found of lasting value to those interested in the progress and development of scientific agriculture and the knowledge of agricultural progress fostered by the Government of the United States.

Matter relating to the system of promotions among the body of employees of the Department and also the mode of appointing mere laborers will be found instructive.

In conclusion, I feel it my duty to most cordially commend the assiduity, capacity, and intelligence of my assistants in the work of this office during the year. Their work is not very evident to the public generally. Their field of labor is not in the eye of the people, but like the internal mechanism of a watch, while it largely systematizes and regulates, according to both statutory law and civil-service rules, the administrative work of the Department, the peculiar mechanism by which this is done is not much in evidence. I urge a reasonable increase in the compensation of the clerks employed in this branch of your office.

Number of employees in the several Bureaus, Divisions, and Offices in the United States Department of Agriculture on July 1, 1904.

Office of the Secretary of Agriculture	70
Weather Bureau	1,357
Bureau of Animal Industry	1,495
Bureau of Plant Industry	493
Bureau of Forestry	307
Bureau of Chemistry	82
Bureau of Soils	129
Bureau of Statistics	151
Bureau of Entomology	78
Division of Biological Survey	26
Division of Accounts and Disbursements	16
Division of Publications	158
Office of Experiment Stations	102
Office of Public Road Inquiries	22
Department library	12
Museum	4
Contingent expenses	2
Total	4,504
Number of employees in the several Bureaus, Divisions, and Offices in the U. S. Department of Agriculture on July 1, 1903	4,200
Increase to July 1, 1904	304

OFFICERS AND EMPLOYEES OF THE DEPARTMENT ON JULY 1, 1904, BY BUREAUS, DIVISIONS, AND OFFICES.

OFFICE OF THE SECRETARY.

Secretary and his assistants, 10; clerks, 19; engineers, firemen, electricians, mechanics, plumbers, messengers, watchmen, laborers, and charwomen, 41; total, 70.

WEATHER BUREAU.

Chief and Assistant Chief of the Bureau, chiefs of divisions, librarians, etc., 10; professors of meteorology, 6; clerks and copyists, 82; compositors, lithographers, printers, and printing office employees, 47; mechanics, engineers, skilled artisans, firemen, batterymen, repairmen, messengers, watchmen, laborers, and charwomen, 178; inspectors, 3; district and local forecasters, 37; section directors, 34; observers and assistant observers, 279; station agents and student

assistants, 5; river and rainfall observers, 177; rainfall observers, 42; cotton region observers, 141; sugar and rice observers, 9; corn and wheat region observers, 135; fruit and wheat observers, 19; hurricane observers, 3; storm warning displaymen, 150; total, 1,357.

BUREAU OF ANIMAL INDUSTRY.

Chief and Assistant Chief of the Bureau, chief clerk and chiefs and assistant chiefs of divisions in the Bureau, 10; inspectors, special inspectors, assistant inspectors, and vessel inspectors, 448; live stock agents, special agents, and field stock examiners, 41; stock examiners and special stock examiners, 227; taggers, 278; microscopists and assistant microscopists, 239; clerks and assistants, 92; experts, scientific assistants, aids, etc., 18; editor, 1; illustrator, 1; dairy inspectors, butter and cheese experts, etc., 11; painters, carpenters, firemen, laborers, messengers, charwomen, etc., 129; total, 1,495.

BUREAU OF PLANT INDUSTRY.

Chief of the Bureau, chief clerk and assistant clerks, 5; engaged in vegetable pathological and physiological investigations, 144; engaged in botanical investigations, 57; engaged in pomological investigations, 29; engaged in foreign seed and plant importation and distribution, 12; engaged in tea-culture investigations, 6; engaged in grass and forage-plant investigations, 42; engaged in the purchase and distribution of valuable domestic seeds, 84; engaged in domestic sugar investigations, 4; engaged in experimental gardens and grounds, 25; engaged in greenhouse clearing, 6; engaged on and in connection with the Arlington Experimental Farm, 19; engaged in cotton boll weevil investigations, 60; total, 493.

BUREAU OF FORESTRY.

Forester and Chief of Bureau, Associate Forester, and assistant foresters, 9; forest inspectors and assistant forest inspectors, 7; civil engineers, scientific assistant, lumberman, timber testers, and dendro-chemist, 11; miscellaneous experts, agents, forest experts, forest assistants, assistant forest experts, collaborators, forest agents, and forest students, 190; clerks, computers, librarian, draftsmen, photographers, 57; messengers, watchmen, laborers, and charwomen, 33; total, 307.

BUREAU OF CHEMISTRY.

Chief of the Bureau and assistant chemists, 9; chiefs of divisions and chiefs of laboratories and their assistants, 11; student assistants, 9; scientific aids, 4; scientific assistants, 6; special agents, 12; chief clerk and assistant clerks, 10; engineers, petrographer, assayers, and instrument machinist, 6; messengers, laborers, watchmen, and charwomen, 15; total, 82.

BUREAU OF SOILS.

Chief of Bureau, clerks, and administrative assistants, 33; scientific assistants, etc., in chemistry, 9; scientific assistants in soil physics, 6; scientific assistants in soil survey, 41; scientific assistants in soil management, 18; scientific assistants and experts in tobacco production, etc., 13; scientific assistants, etc., in the reclamation of soils, 9; total, 129.

BUREAU OF ENTOMOLOGY.

Entomologist and Chief of Bureau, assistants, clerks, librarian, draftsmen, and skilled laborers, 28; special field agents, 11; apiculturists, 3; sericulturists, 5; cotton boll weevil investigators, 22; cotton bollworm investigators, 4; messengers, laborers, and charwomen, 5; total, 78.

BUREAU OF STATISTICS.

Chief and assistant chief of the Bureau and assistant statisticians, chiefs of divisions, and chief clerk, 8; clerks and compilers, 56; clerical laborers, 22; messengers, workmen, and charwomen, 6; cotton agents, 7; special agents at Minnesota Experiment Station, 3; special field agents, 8; special station agents, 2; State statistical agents, 40; total, 152.

DIVISION OF BIOLOGICAL SURVEY.

Biologist and Chief, 1; assistant biologists, 14; biological experts temporarily employed, 2; field naturalist, 1; field expert temporarily employed, 1; clerks, 3; warden (in charge Pelican Island), 1; charwoman, 1; total, 26.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

Chief of the Division and Disbursing Clerk, assistant chief, cashier, and custodian of files, 4; clerks, 12; total, 16.

DIVISION OF PUBLICATIONS.

Chief of the Division and Editor, associate and assistant editors, and editorial clerks, 9; engravers, draftsmen, photographers, laborers (clerical), and messengers, 14; chief clerk and assistant clerks, 12; assistant in charge of document section, assistants, chief folders, foremen, folders, skilled laborers, folder laborers, laborers, messengers, and watchmen, 123; total, 158.

DEPARTMENT LIBRARY.

Librarian and assistant librarian, 2; cataloguers, 3; clerks, 4; student assistant, 1; messengers, 2; total, 12.

MUSEUM.

Caretaker and charwomen, 4.

CONTINGENT SECTION.

Carpenter, 1; painter, 1; total, 2.

OFFICE OF EXPERIMENT STATIONS.

Director and Assistant Director of the Office, chiefs of divisions, assistants, clerks, messengers, and laborers, 24; chief of Irrigation and Drainage Investigations, assistants, agents, experts, clerks, messengers, and laborers, 45; chief of Nutrition Investigations, assistants, agents, experts, computers, and clerks, 16; special agent in charge of Porto Rico Agricultural Experiment Station and assistants, 6; special agent in charge of the Alaska Agricultural Experiment Station and assistants, 5; special agent in charge of the Hawaiian Agricultural Experiment Station and assistants, 4; farmers' institute specialist and assistant, 2; total, 102.

OFFICE OF PUBLIC ROAD INQUIRIES.

Director and Assistant Director, 2; clerks, etc., 5; experts and special agents in road building object lessons, 15; total, 22.

SPECIAL OBSERVERS AND CORRESPONDENTS.

The following shows the number of special observers and correspondents of the Department receiving no monetary remuneration from the Department of Agriculture.

WEATHER BUREAU.

Voluntary observers in cooperation with the Weather Bureau, 3,367; voluntary crop correspondents in cooperation with the Weather Bureau, 13,406.

BUREAU OF STATISTICS.

State agents' aids, 9,599; cotton correspondents and aids, 10,976; township correspondents, 34,435; individual farmers, 72,060; cotton ginners, 45,000; special cotton correspondents, 16,864; millers, etc., 24,074; total in Bureau of Statistics, 213,008.

Voluntary correspondents in the Weather Bureau, 16,773; total voluntary correspondents, 229,781.

NOTE.—Reports from the above-mentioned correspondents in the Bureau of Statistics are received monthly, supplemented from time to time by the reports of farmers and planters, bankers, merchants, public and private cotton ginners, and the representatives of flour mills and of railroads.

CHANGES IN THE FORCE OF EMPLOYEES IN THE DEPARTMENT DURING THE FISCAL YEAR ENDED JUNE 30, 1904.

The following shows the number of appointments and changes in the officers and employees in the classified, in the excepted, and in the unclassified civil service in the United States Department of Agriculture during the fiscal year beginning July 1, 1903, and terminating June 30, 1904:

IN THE UNEXCEPTED CLASSIFIED SERVICE.

Probational appointments	359
Absolute appointments at end of probational period	334
Transfers to this Department	34
Transfers from this Department	0
Promotions	594
Reductions	39
Emergency and temporary appointments	207
Failures to accept appointment	72
Separations by resignation, termination, or removal	281
Separations by death	19

IN THE EXCEPTED CLASSIFIED SERVICE.

Appointments to temporary positions excepted from examination and certification in the classified service, including agents, experts, student assistants, assistant forest experts, collaborators, corn and wheat observers, fruit and wheat observers, cotton-region and sugar and rice observers, storm-warning displaymen, and river and rainfall observers	1,013
Separations from temporary positions excepted from examination and certification in the classified service, including agents, experts, student assistants, assistant forest experts, collaborators, corn and wheat observers, fruit and wheat observers, cotton-region and sugar and rice observers, storm-warning displaymen, and river and rainfall observers	952

IN THE UNCLASSIFIED SERVICE.

Appointments in the unclassified service	24
Separations from unclassified service (including 4 by death)	65

Separations by death during the fiscal year ending June 30, 1904.

Month and year.	Number of deaths.	Name.	Date of death.
1903.			
July	2	John S. Neagle	July 27
		George W. Pierce	July 28
August	1	Catherine I. Shaffer	Aug. 22
September	1	Matie Kneeland	Sept. 13
December	1	Teresa M. Chapman	Dec. 20
1904.			
January	4	John Forbes	Jan. 3
		Mary Anderson	Do.
		Julius R. Frederick	Jan. 6
		Hiram P. Hottenstein	Jan. 13
February	3	Samuel M. Blandford	Feb. 9
		Emil E. de Schweinitz	Feb. 15
		L. Elmond Gallagher	Feb. 29
March	4	Mary H. Crosby	Mar. 8
		J. E. Markley	Do.
		Gideon S. Jones	Mar. 9
		Annette M. Dye	Mar. 19

Separations by death during the fiscal year ending June 30, 1904—Continued.

Month and year.	Number of deaths.	Name.	Date of death.
1904.			
April	2	Robert H. Carter	Apr. 8
		James W. Davis	Apr. 22
May	1	Frederick A. Walpole	May 11
June	5	Frederick H. Clarke	June 8
		Lawrence Gallagher	June 11
		Virginia Miller	June 18
		John C. Lamont	June 27
		Joseph H. Brigham[a]	June 29
Total	24		

[a] The following memorial is self-explanatory:

IN MEMORIAM.

Joseph H. Brigham was appointed Assistant Secretary of Agriculture on March 22, 1897, by President William McKinley. He died at Delta, Ohio, at 11 p. m., Wednesday, June 29, 1904.

At a meeting of the Chiefs of Bureaus and Divisions of the U. S. Department of Agriculture, held June 30, 1904, at which the Secretary of Agriculture presided, the following memorial on the death of Assistant Secretary J. H. Brigham was adopted:

"We have learned with profound sorrow of the death of Colonel Joseph H. Brigham, late Assistant Secretary of this Department.

"During a service of over seven years as Assistant Secretary, Colonel Brigham, by his qualities of heart and head, deserved and gained the confidence and esteem of all with whom he had official relations. In addition, he won and held the personal regard of all who knew him.

"The lasting achievements of his busy life, especially his services to agriculture, have won for his name an enduring renown—no less marked than the love and affection which follow him to the grave.

"We desire that a copy of this memorial be given to the bereaved family as a mark of our sympathy and a token of our regard.

"H. W. WILEY.
"JOSEPHINE A. CLARK.
"F. L. EVANS."

OFFICERS OF THE U. S. DEPARTMENT OF AGRICULTURE.

In the table following are shown the name, State, position, and salary of the officers of the Department July 1, 1904.

Name, State, position, and salary of officers of Department of Agriculture July 1, 1904.

Name.	State.	Position.	Salary.
James Wilson	Iowa	Secretary	$8,000
Vacant		Assistant Secretary	4,500
Jasper Wilson	Iowa	Private secretary to Secretary	2,500
Sylvester R. Burch	Kansas	Chief Clerk	2,500
Joseph B. Bennett	Wisconsin	Appointment Clerk	2,000
Cyrus B. Lower	Pennsylvania	Chief of Supply Division	2,000
Willis L. Moore	New York	Chief of Weather Bureau	5,000
Henry E. Williams	Connecticut	Assistant chief of Weather Bureau	3,000
Daniel J. Carroll	Dist. of Columbia.	Chief clerk of Weather Bureau	2,250
Cleveland Abbe	New York	Professor of meteorology	3,000
Frank H. Bigelow	Massachusetts	do	3,000
Charles F. Marvin	Ohio	do	3,000
Daniel E. Salmon	North Carolina	Chief of Bureau of Animal Industry	4,500
Alonzo D. Melvin	Illinois	Assistant chief of Bureau of Animal Industry.	2,500
Edward D. Jones	Indiana	Chief clerk of Bureau of Animal Industry.	2,000
A. M. Farrington	New Jersey	Chief of Inspection Division	2,500
Vacant		Chief of Dairy Division	2,500
John R. Mohler	Pennsylvania	Chief of Pathological Division	2,500
Marion Dorset	do	Chief of Biochemic Division	2,500
Richard W. Hickman	do	Zoologist	2,500
Ernest C. Schroeder	Maryland	Superintendent of Experiment Stations	2,000
Beverly T. Galloway	Missouri	Chief of Bureau of Plant Industry	4,500
Albert F. Woods	Nebraska	Plant pathologist and physiologist in charge.	3,000
George T. Moore	New Hampshire	Plant physiologist and pathologist	2,750

Name, State, position, and salary of officers of Department of Agriculture July 1, 1904—Continued.

Name.	State.	Position.	Salary.
Erwin F. Smith	Michigan	Pathologist	$2,750
Herbert J. Webber	Missouri	do	2,750
Merton B. Waite	Illinois	Assistant pathologist	2,250
Mark A. Carleton	Kansas	Cerealist	2,500
James E. Jones	Ohio	Chief clerk of Bureau of Plant Industry.	2,000
Frederick V. Coville	New York	Botanist in charge	3,000
Lyster H. Dewey	Michigan	Botanist	2,500
Orator F. Cook	New York	do	2,750
Rodney H. True	Massachusetts	Physiologist	2,500
Gustavus B. Brackett	Iowa	Pomologist in charge	3,000
William A. Taylor	Michigan	Pomologist	2,500
G. Harold Powell	Delaware	do	2,500
William J. Spillman	Washington	Agrostologist	3,000
Albert S. Hitchcock	Kansas	do	2,500
Lee C. Corbett	West Virginia	Horticulturist	2,750
Adrian J. Pieters	Michigan	Botanist	2,750
Edward M. Byrnes	Maryland	Head gardener	1,800
Robert J. Whittleton	Illinois	Superintendent of weighing and mailing section, Seed Distribution.	2,000
Charles F. Saylor	Iowa	Special agent and investigator of domestic sugar production.	per m. 225
Gifford Pinchot	New York	Forester and chief of the Bureau of Forestry.	3,500
Overton W. Price	North Carolina	Assistant forester and assistant chief of the Bureau of Forestry.	2,700
George B. Sudworth	Michigan	Assistant forester	2,500
Hermann von Schrenk	Missouri	Expert in charge, forest products	2,500
William K. Hatt	Indiana	Civil engineer	2,250
Harvey W. Wiley	do	Chemist and chief of the Bureau of Chemistry.	3,500
Willard D. Bigelow	Kansas	Assistant chemist	2,500
Logan W. Page	Massachusetts	Chief of the road material laboratory	2,500
John K. Haywood	New York	Chief of the insecticide and agricultural water laboratory.	2,250
Lyman F. Kebler	Pennsylvania	Chief of the drug laboratory	2,250
Allerton S. Cushman	Connecticut	Chemist, road material laboratory	2,000
Milton Whitney	Maryland	Soil physicist and chief of the Bureau of Soils.	3,500
Frank D. Gardner	Illinois	Scientist	2,500
Frank K. Cameron	Maryland	Scientist and soil chemist	3,000
Lyman J. Briggs	Michigan	Soil physicist	2,500
Albert G. Rice	Kentucky	Chief clerk of Bureau of Soils	2,000
Clarence W. Dorsey	Ohio	Soil scientist	2,500
John Hyde	Nebraska	Statistician and Chief of Bureau of statistics.	3,500
Stephen D. Fessenden	Massachusetts	Assistant statistician and assistant chief of Bureau of Statistics.	2,200
George K. Holmes	do	Chief of the Division of Foreign Markets.	2,500
Frank R. Rutter	Maryland	Assistant chief of the Division of Foreign Markets.	1,800
Leland O. Howard	New York	Entomologist and Chief of the Bureau of Entomology.	3,250
Daniel W. Coquillett	California	Assistant entomologist and assistant chief of the Bureau of Entomology.	1,800
Charles L. Marlatt	Kansas	Entomologist in charge of experimental field work.	2,750
Frank H. Chittenden	New York	Entomologist in charge of breeding experiments.	2,000
Martin Dodge	Ohio	Director of the Office of Public Road Inquiries.	3,000
Maurice O. Eldridge	Tennessee	Assistant director of the Office of Public Road Inquiries.	1,800
Alfred C. True	Connecticut	Director of the Office of Experiment stations.	3,500
Edwin W. Allen	Massachusetts	Assistant director of the Office of Experiment Stations.	2,000
Walter H. Beal	Virginia	Chief of the editorial division, Office of Experiment Stations.	2,000
Walter H. Evans	Indiana	Chief of division of insular stations, Office of Experiment Stations.	2,250
Wilbur O. Atwater	Connecticut	Chief of nutrition investigations, Office of Experiment Stations.	2,000
Elwood Meade	Wyoming	Chief of irrigation investigations	3,000
John Hamilton	Pennsylvania	Farmers' institute specialist, Office of Experiment Stations.	2,250
Charles C. Georgeson	Kansas	Special agent in charge of Alaska experiment station.	3,000
Jared G. Smith	Missouri	Special agent in charge of Hawaii experiment station.	3,000
C. Hart Merriam	New York	Biologist and chief of the Division of Biological Survey.	2,750

Name, State, position, and salary of officers of Department of Agriculture July 1, 1904—Continued.

Name.	State.	Position.	Salary.
Albert K. Fisher	New York	Assistant biologist and assistant chief of the Division of Biological Survey.	$2,250
Theodore S. Palmer	California	Assistant in charge of game preservation and introduction, Division of Biological Survey.	2,500
Foster E. L. Beal	Massachusetts	Economic ornithologist, Division of Biological Survey.	2,400
George W. Hill	Minnesota	Editor and Chief of the Division of Publications.	3,000
Joseph A. Arnold	Indiana	Associate editor	2,250
Benj. D. Stallings	Virginia	Assistant editor, Division of Publications.	2,000
Robert B. Handy	do	Assistant in charge of document section, Division of Publications.	1,800
Frank L. Evans	Pennsylvania	Chief of Division of Accounts and Disbursements and Disbursing Clerk.	2,750
Almerico Zappone	Dist. of Columbia	Assistant chief of the Division of Accounts and Disbursements.	2,000
Miss Josephine A. Clark	Massachusetts	Librarian	2,000
Nathaniel Shatswell	do	Caretaker of the Museum	1,000

THE U. S. DEPARTMENT OF AGRICULTURE IN THE CLASSIFIED CIVIL SERVICE.

The officers, clerks, and other employees of the U. S. Department of Agriculture in Washington, D. C., on December 12, 1884, were first classified and brought under the operation of the civil-service act approved January 16, 1883. This was done under the approval of President Chester A. Arthur. One hundred and eighteen persons were included in that classification.

EXTRACT FROM THE FOURTH REPORT OF THE U. S. CIVIL SERVICE COMMISSION.

"In a written communication, bearing no date, addressed to the Commission, and received November 24, 1884, the Commissioner of Agriculture submitted a 'list of clerks in the U. S. Department of Agriculture classified in accordance with the act entitled "An act to regulate and improve the civil service of the United States," approved January 16, 1883.'"

By this list the employees of the Department of Agriculture were arranged into the following classes:

1. Clerks of class 1, $1,200 per annum.
2. Clerks of class 2, $1,400 per annum.
3. Clerks of class 3, $1,600 per annum.
4. Clerks of class 4, $1,800 per annum.
5. Clerks at $1,000 per annum each.
6. Clerks at $840 per annum each.
7. Clerks at $720 per annum each.
8. Clerk to Bureau of Animal Industry.
9. Disbursing officer.
10. Assistant to disbursing officer.
11. Librarian.
12. Superintendent of folding room.
13. Employees in the chemical bureau.
14. Employees in the laboratory.
15. Employees in the botanical bureau.
16. Employees in the Bureau of Entomology.
17. Employees in the museum.
18. Foreman in the grounds.

"On December 10, 1884, the President, by telephonic message, informed the Commission of the receipt by him of this classification of the Department of Agriculture, and asked the attention of the Commission to the same. In reply, the Commission, on December 11, informed the President that the classification had been made in pursuance of his views as expressed to the Commission in an interview in October, 1884, and which had been communicated to the Commissioner of Agriculture.

"On December 16, 1884, the Commission received from the President, by his private secretary, a communication dated December 12, in which the information was given that this classification of the Department of Agriculture had been accepted and approved.

"Since that date the Department of Agriculture has been regarded and treated by the Commission as a Department operated upon by the civil-service act and rules."—*Fourth Report of the United States Civil Service Commission, pages 110 and 111.*

EXTENSIONS OF THE CLASSIFIED CIVIL SERVICE IN THE U. S. DEPARTMENT OF AGRICULTURE UNDER ORDERS ISSUED BY SUCCESSIVE PRESIDENTS.

A large class of employees in Washington, D. C., numbering 116 persons, were, on June 30, 1888, classified.

The positions of observers, local forecast officials, and assistants in the Weather Bureau, outside of Washington, D. C., were classified on January 5, 1893, carrying 314 persons into the classified service.

The position of Appointment Clerk was classified on March 20, 1894.

The positions of inspectors and assistant inspectors, outside of Washington, D. C., in the Bureau of Animal Industry, were classified on July 1, 1894, carrying 67 persons into the classified service.

The positions of professors of meteorology in the Weather Bureau, Washington, D. C., were classified June 6, 1894, carrying 3 persons into the classified service.

The positions of chiefs and assistant chiefs of entomology and of ornithology were classified on July 12, 1894, carrying 4 persons into the classified service.

The positions of chief and assistant chief of pomology were classified on November 6, 1894, carrying 2 persons into the classified service.

The positions of messengers, assistant messengers, watchmen, plant mounters, and folders were classified on November 2, 1894, carrying 117 persons into the classified service.

The positions of chiefs and assistant chiefs of divisions, experts, artists, State statistical agents in the various bureaus and offices of the Department, and the positions of microscopists, assistant microscopists, taggers, stock examiners, clerks, and agents in the Bureau of Animal Industry were classified on July 1, 1895, carrying 754 persons into the classified service.

The position of messenger in the Weather Bureau, outside of Washingon, D. C., was classified July 1, 1895.

The position of fireman was classified on July 15, 1895, carrying 12 persons into the classified service.

The positions of clerical laborers, messenger-laborers, carpenters, gardeners, mechanics, painters, etc., were classified on September 18, 1896, carrying 91 persons into the classified service.

Total number of persons carried into the classified service under the orders of the President, 1,599.

EXAMINATIONS HELD BY THE U. S. CIVIL SERVICE COMMISSION DURING THE FISCAL YEAR BEGINNING JULY 1, 1903, AND TERMINATING JUNE 30, 1904, FOR POSITIONS IN THE U. S. DEPARTMENT OF AGRICULTURE.

July 7–8, 1903, for game law assistant (male), in the Division of Biological Survey; salary, $1,200 per annum.

August 1, 1903, for dairy inspector (male), in the Bureau of Animal Industry; salary from $1,500 to $1,800 per annum.

August 26, 1903, for commercial telegraph and telephone operator; salary, $1,200 per annum.

August 26, 1903, for entomological draftsman, Division of Entomology; salary, $1,000 per annum.

September 2, 1903, for testing engineer (male), in the Bureau of Forestry; salary $1,200 to $1,500 per annum.

September 17, 1903, for stenographer, typewriter, and indexer (female), in the Bureau of Animal Industry; salary, $840 per annum.

October 15, 1903, for superintendent of testing gardens (male), in the Bureau of Plant Industry; salary, $3,000 per annum.

October 21, 1903, for observer (male), in the Weather Bureau; salary, $720 per annum.

October 21, 1903, scientific assistants (male or female); salary, $600 to $1,200 per annum; qualified in some one of the following lines:

(1) Agricultural statistics.
(2) Agrostology.
(3) Animal bacteriology.
(4) Animal pathology.
(5) Animal production and dairying.
(6) Agricultural chemistry.
(7) Analytical chemistry—methods for the detection of food adulteration.
(8) Analytical chemistry—official methods, except food adulteration.
(9) Analytical chemistry—qualitative, quantitative, and industrial.
(10) Economic botany.
(11) Botany.
(12) Forestry.
(13) Horticulture.
(14) Library science.
(15) Ornithology and mammalogy.
(16) Physics, as applied to meteorology, soils, and irrigation.
(17) Physiology and nutrition of man.
(18) Plant bacteriology.
(19) Plant breeding.
(20) Plant pathology.
(21) Plant physiology.
(22) Pomology.
(23) Practice of agriculture.
(24) Rural engineering, especially as applied to road making and irrigation.
(25) Seed testing.
(26) Zoology.

(The holding of this examination was postponed until a later date because of the absence of applications.)

November 7, 1903, for cook, Bureau of Chemistry; salary, $30 per month and board.

November 11, 1903, for assistant in soil management (male), in the Bureau of Soils; salary, $1,000 to $1,400 per annum.

February 3, 1904, for stenographer and typewriter with knowledge of chemistry, especially as applied to the analysis of agricultural waters and insecticides (male or female), in the Bureau of Chemistry; salary, $660 per annum.

March 1, 1904, for pharmacologist (male), in the Bureau of Plant Industry; salary, $1,800 per annum.

March 2, 1904, for chemical clerk (male or female), in the Bureau of Chemistry; salary, $600 per annum.

April 13, 1904, for assistant photographer (male or female); salary, $840 per annum.

April 19, 1904, for scientific assistants (male or female); salary, $660 to $1,200 per annum; the specific classes of scientific assistants, as specified in the examination therefor, held on October 21, 1903, apply to this examination.

April 19, 1904, for meat inspector (male), in the Bureau of Animal Industry; salary, $1,200 per annum.

April 19, 1904, for field assistant in forestry (male), in the Bureau of Forestry; salary, $1,000 to $1,500 per annum.

May 11–12, 1904, for assistant biologist and editor (male), in the Division of Biological Survey; salary, $1,200 per annum.

June 4, 1904, for food inspection chemist (male), in the Bureau of Chemistry; salary, $2,000 per annum.

June 15, 1904, for laboratory aid in physiology and pathology (male or female), in the Bureau of Plant Industry; salary, $720 per annum.

June 15, 1904, for messenger boy at Huron, S. Dak., in the Weather Bureau; salary, $360 per annum.

June 15, 1904, for messenger boy at Minneapolis, Minn., in the Weather Bureau; salary, $360 per annum.

June 15, 1904, for messenger boy at Cairo, Ill., in the Weather Bureau; salary, $360 per annum.

June 29, 1904, for messenger boy at Boise, Idaho, in the Weather Bureau; salary, $360 per annum.

June 29, 1904, for messenger boy at Atlantic City, N. J., in the Weather Bureau; salary, $360 per annum.

June 29, 1904, for messenger boy at Memphis, Tenn., in the Weather Bureau; salary, $360 per annum.

June 29, 1904, for messenger boy at Seattle, Wash., in the Weather Bureau; salary, $360 per annum.

June 29, 1904, for messenger boy at Cheyenne, Wyo., in the Weather Bureau; salary $360 per annum.

The last examination for tagger (male), in the Bureau of Animal Industry, salary $720 per annum, was held in April, 1903, when over one thousand applicants were examined. The list of eligibles resulting from that examination not being exhausted, no examination was held during the fiscal year ending June 30, 1904.

The salaries as attached to the above positions are the commencement salaries.

REGULATIONS GOVERNING OFFICERS AND EMPLOYEES AND THEIR APPOINTMENT IN THE U. S. DEPARTMENT OF AGRICULTURE.

By the provisions of the civil-service act, approved January 16, 1883, and the rules of the U. S. Civil Service Commission, approved by the President, all positions in the U. S. Department of Agriculture, except those of mere manual unskilled laborers, including charwomen, are now embraced in the classified civil service, and appointments thereto can now be made only from certificates issued by the U. S. Civil Service Comission except in the cases of special agents and experts.

All persons seeking information respecting the classified civil service and examinations for positions therein should address the U. S. Civil Service Commission, Washington, D. C. A manual of examinations for the classified civil service of the United States is published by the U. S. Civil Service Commission for the information and guidance of all persons interested therein.

No person can be appointed to the position of mere laborer or charwoman—that is, to do common manual labor or cleaning rooms, halls, stairways, etc., requiring ample physical strength and capacity—except in accordance with the regulations governing such appointments. No person so appointed can be allowed to do any duties that are held by

the civil-service rules and regulations to be classified duties—that is, duties for which examinations have been or may be held by the Civil Service Commission.

Any person holding an appointment to a position in any other Department or officially connected with any other branch of the Government service will not, while holding such appointment, be employed in any capacity, even temporarily, in the U. S. Department of Agriculture.

To every person appointed to any position in the U. S. Department of Agriculture a written appointment, signed by the Secretary (or Acting Secretary) of Agriculture, will be issued, stating the title or name of the position to which appointed and describing in general terms the character of the service to be performed by and specifying the salary or the rate of compensation to be paid to the person so appointed and the specific roll or fund provided in the act making appropriations for the Department of Agriculture from which paid.

Every appointee will be required to take an oath (or affirmation) of office in the form prescribed by law before entering upon his duties, and file the same, together with a statement of legal residence, post-office address, and personal record, with the Appointment Clerk of the Department, on a form provided by the Department.

In every case in which the issue of a new appointment becomes necessary, as in promotions, reappointments, transfers, and changes of official designation, a new oath and a statement of personal record will be required, unless otherwise directed in the appointment.

The oath of office of appointees to positions in the U. S. Department of Agriculture may be taken before any officer having an official seal, with authority to administer oaths either by United States statutes or by local municipal law, and it must be properly certified under the hand and seal of such officer. The oath of office may also be taken before the Chief Clerk of the U. S. Department of Agriculture or before the chief clerk of any Bureau thereof.

Neither salary nor other emoluments will be paid to any employee until the required oath of office shall have been filed with the Appointment Clerk of the Department, nor until the appointee shall have reported for duty according to his instructions. If a specific date is named upon which the appointment is to take effect, salary will not begin until that date, although the oath may have been taken earlier.

EXTRACTS FROM LAWS.

The following are extracts from the United States statutes bearing upon the civil service:

Act of May 1, 1884:

* * * Hereafter no Department or officer of the United States shall accept voluntary service for the Government or employ personal service in excess of that authorized by law, except in cases of sudden emergency involving the loss of human life or the destruction of property. (23 Stat. L., 17; Sup. R. S., vol. 1, 2d ed., p. 427.)

Act of March 15, 1898:

SEC. 7. Hereafter it shall be the duty of the heads of the several Executive Departments, in the interest of the public service, to require of all clerks and other employees, of whatever grade or class, in their respective Departments,

not less than seven hours of labor each day, except Sundays and days declared public holidays by law or Executive order: *Provided*, That the heads of the Departments may, by special order stating the reason, further extend the hours of any clerk or employee in their Departments, respectively; but in case of an extension it shall be without additional compensation: *Provided further*, That the head of any Department may grant thirty days' annual leave, with pay, in any one year to each clerk or employee: *And provided further*, That where some member of the immediate family of a clerk or employee is afflicted with a contagious disease and requires the care and attendance of such employee, or where his or her presence in the Department would jeopardize the health of fellow-clerks, and in exceptional and meritorious cases, where a clerk or employee is personally ill, and where to limit the annual leave to thirty days in any one calendar year would work peculiar hardship, it may be extended, in the discretion of the head of the Department, with pay, not exceeding thirty days in any one case or in any one calendar year.

This section shall not be construed to mean that so long as a clerk or employee is borne upon the rolls of the Department in excess of the time herein provided for or granted that he or she shall be entitled to pay during the period of such excessive absence, but that the pay shall stop upon the expiration of the granted leave. (30 Stat. L., 316; Sup. R. S., vol. 2 (No. 8), pp. 736, 737, sec. 7.)

Act of July 7, 1898:

* * * Nothing contained in section seven of the act making appropriations for legislative, executive, and judicial expenses of the Government for the fiscal year eighteen hundred and ninety-nine, approved March fifteenth, eighteen hundred and ninety-eight, shall be construed to prevent the head of any Executive Department from granting thirty days' annual leave, with pay, in any one year to a clerk or employee, notwithstanding such clerk or employee may have had during such year not exceeding thirty days' leave, with pay, on account of sickness, as provided in said section seven. (30 Stat. L., 653; Sup. R. S., vol. 2 (No. 8), p. 882, par. 1.)

Act of February 24, 1899:

SEC. 4. * * * *Provided*, That the thirty days' annual leave of absence, with pay, in any one year to clerks and employees in the several Executive Departments authorized by existing law shall be exclusive of Sundays and legal holidays. (30 Stat. L., 890; Sup. R. S., vol. 2 (No. 8), pp. 946, 947, sec. 4.)

Act of May 25, 1900:

* * * The employees of the Bureau of Animal Industry outside of the city of Washington may hereafter, in the discretion of the Secretary of Agriculture, be granted leaves of absence not to exceed fifteen days in any one year. (31 Stat. L., p. 202.)

Act of March 2, 1901:

Weather Bureau Service. * * * Thirty local forecast officials, section directors, observers, operators, repair men, messengers, boy messengers, laborers, and other necessary employees outside of the city of Washington, * * * without additional expense to the Government may hereafter, in the discretion of the Secretary of Agriculture, be granted such leaves of absence as are now authorized to employees in the office of the Chief of the Weather Bureau, not to exceed thirty days in any one year. * * * (31 Stat. L., p. 924.)

Act of July 31, 1894:

SEC. 2. * * * No person who holds an office, the salary or annual compensation attached to which amounts to the sum of two thousand five hundred dollars, shall be appointed to or hold any other office to which compensation is attached unless specially heretofore or hereafter specially authorized thereto by law; but this shall not apply to retired officers of the Army or Navy whenever they may be elected to public office or whenever the President shall appoint them to office by and with the advice and consent of the Senate. (28 Stat. L., 205; Sup. R. S., vol. 2 (No. 4), p. 212, sec. 2.)

REGULATIONS.

Following are regulations for the civil service of the Department of Agriculture:

REGULATIONS GOVERNING PROMOTIONS, ETC., IN THE U. S. DEPARTMENT OF AGRICULTURE IN FORCE ON JULY 1, 1904.

OFFICE OF U. S. CIVIL SERVICE COMMISSION,
Washington, D. C., December 1, 1896.

In pursuance of the requirements of section 7 of "An act to regulate and improve the civil service of the United States," approved January 16, 1883, and in conformity with Rule XI of the revision of the civil-service rules promulgated by the President on the 6th day of May, 1896, the following regulations governing promotions in the departmental service of the Department of Agriculture have been formulated by the Civil Service Commission after consultation with the Secretary of Agriculture, and are hereby promulgated.

Regulation I.

SECTION 1. All vacancies above those in the lowest class of any grade not filled by reinstatement, transfer, or reduction shall be filled by promotion: *Provided*, That if there is no person eligible for promotion, or if the vacant position requires the exercise of technical or professional knowledge, it may be filled through certification by the Civil Service Commission.

SEC. 2. Except as provided in section 1 of this regulation, a vacancy in any class shall be filled by the promotion of an eligible in the next lower class of the same Bureau, Division, or Office. When such vacancy exists the board of promotion review shall certify to the Secretary of Agriculture the names of the three eligibles in the Bureau, Division, or Office having the highest records of efficiency, and from these names the Secretary of Agriculture shall make his selection: *Provided*, That if there shall be in the Bureau less than three eligibles in the class next below that in which the vacancy exists, the board of promotion review shall certify as many in addition of the highest eligibles in the corresponding class of the other Bureaus as may be necessary to make a full certification.

Regulation II.

SECTION 1. No person shall be promoted to any grade from which he is barred by the age limitations prescribed by the civil-service rules.

SEC. 2. No person whose record of efficiency is below 85 per cent of the possible maximum rating of his class or grade shall be eligible for promotion.

SEC. 3. No person occupying a position below the grade of clerk-copyist shall be promoted to that grade until he shall have been employed two years in the departmental service and shall have passed, with an average percentage of 70 or over, the examination prescribed by the Commission.

Regulation III.

SECTION 1. The chief clerk of each bureau, under the direction of the head thereof, shall keep a record of the efficiency of all employees under his supervision, and a similar record of employees not assigned to any bureau shall be kept by the chief clerk of the Department.

SEC. 2. The record of efficiency shall be kept on such forms as may be prescribed by the Commission after consultation with the Secretary of Agriculture, and shall embrace the elements which are essential to a fair and accurate determination of the relative merits of employees.

SEC. 3. A record of those eligible for promotion shall be kept by the board of promotion review. The board shall have access to efficiency records, and may at any time call for a transcript of the same.

SEC. 4. The efficiency reports made by the chiefs of the several Bureaus, Divisions, and Offices of the Department of Agriculture respecting the value of the personal services in the Department of each person serving under them, and filed with the appointment clerk for the chief clerk of the Department, shall

be the basis of all promotions, demotions, and continuations on the rolls of the Department.

SEC. 5. The following shall be the form of efficiency report to be used in the Department of Agriculture:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.
Washington, D. C., _____, *189*__.

TO THE CHIEF OF THE _____

You are directed to report upon the following-named person as the questions herein propounded may require and to file the report with the appointment clerk for the chief clerk.

J. STERLING MORTON, *Secretary.*

EFFICIENCY REPORT.

M _____ is employed under your supervision. This person's salary is $_____ per annum.

Upon what character of work is this person generally employed? Is it clerical? Supervisory? Routine? Is it of a varied and excepional character? Does it involve original thought, consideration, or investigation? If it is skilled labor, state the kind, and whether it is supervisory or routine. If it is that of messenger, watchman, charwoman, or mere laborer, state the fact. _____

_____

How high on a scale of 10 do you rate the quality of this person's work? ____

How high on a scale of 10 do you rate the quantity of work per month done by this person? _____

How high on a scale of 10 do you rate the punctuality of this person? _____

How high on a scale of 10 do you rate the deportment of this person? _____

How many days absent from duty on account of sickness during the six months last past? _____

How many days absent from duty otherwise than on account of sickness during the six months last past? _____ On account of annual leave? _____ Without leave? _____ Furloughed? _____

Does this person show, in your opinion, any special fitness for work of a higher intellectual character than that to which assigned? _____

_____

Have you any further statement to make respecting this person? If so, make it here. _____

(Signed) _____

No. _____ Chief of the _____

(MEMORANDUM RESPECTING THIS PERSON, COMPILED FROM THE RECORDS OF THE DEPARTMENT.)

First appointed _____, 18___, at a salary of $_____ per annum. _____

_____

Classified civil-service record: _____

_____

_____

SEC. 6. An examination into the relative efficiency of employees, as shown by the efficiency record hereinbefore provided for, and such further tests as the Commission may deem necessary, shall constitute an examination for promotion from one class to another class. No person, except as herein provided, shall be eligible for promotion until he shall have passed such an examination.

SEC. 7. Examinations for promotion from one grade to another grade shall be conducted by the board of promotion examiners at such times as may be fixed by the Commission.

SEC. 8. Efficiency reports shall be called for by the Chief Clerk immediately before the termination of the first half of the fiscal year, and also immediately before the termination of the fiscal year, and may be called for at such other times as the interests of the Department seem to require.

JOHN R. PROCTER,
President Civil Service Commission.

REGULATIONS GOVERNING APPOINTMENT TO POSITIONS OF MERE UNSKILLED LABORER UNDER DEPARTMENT OF AGRICULTURE IN DISTRICT OF COLUMBIA.

In the exercise of power vested in the President by the Constitution and by section 1753 of the Revised Statutes, the following regulations governing appointment to positions of mere manual unskilled laborer under the Department of Agriculture in the District of Columbia, having been recommended by the Secretary of Agriculture and the Civil Service Commission, are hereby approved and promulgated, to be effective from and after July 2, 1902:

1. These regulations shall not have the effect of bringing positions of mere laborer within the provisions of the act of January 16, 1883, known as the civil-service act, or of the rules in pursuance thereof, but the system of appointments hereby established shall be separate and distinct from the classified service.

2. No person shall be appointed to, or employed in, any position of mere laborer under the Department of Agriculture in the District of Columbia except in accordance with these regulations.

3. The Secretary of Agriculture shall appoint a board of labor employment of not less than three members, who shall be officers or employees of the Department of Agriculture, and who shall be divided as nearly as practicable between different political parties.

4. Each applicant shall make application on a form prescribed by the board of labor employment and approved by the Civil Service Commission, showing his age, physical condition, and other qualifications for the performance of mere manual labor, as indicated by his past occupations. The form of application shall be accompanied by certificates or vouchers from three reputable citizens who have knowledge of and are competent to testify as to the applicant's character and qualifications for performing manual labor.

5. Political or religious affiliations of applicants shall not be given any consideration whatever, nor shall political indorsements be received or entertained.

6. Applications of persons over 65 years of age will not be considered, except of honorably discharged United States soldiers or sailors of the civil war or of the Spanish-American war, and of those entitled to the benefits of section 1754, Revised Statutes.

7. Applications shall not be received from persons who are badly crippled or deformed or from persons who are not citizens of the United States. Applicants who claim citizenship through naturalization shall be required to submit to the board documentary proof of their naturalization.

8. Applications shall be received by the board of labor employment at any time. On the first of January and the first of July of each year the board shall determine the relative fitness of each applicant who has filed his application in complete form within the six months preceding; the rating or determination of relative fitness shall be made on a scale of 100 and based upon a careful consideration of the applicant's age, his physical qualifications for performing mere manual labor, and his ability and adaptability to perform such labor, special consideration being given any former service as laborer in the Department. In rating an applicant no credit shall be given for any qualifications which he may possess other than those for the performance of manual labor, as above enumerated. The fact that an applicant can not read and write shall not be considered in determining his rating. Whenever in any case the board is unable to determine satisfactorily the rating of an applicant upon the information furnished in connection with the application, it may secure such further information as it may desire in respect to the applicant's character or ability, and may summon the applicant to appear personally before the board or its representative: *Provided*, That all information or matter which is given any consideration in determining the rating shall be reduced to writing and made a part of the applicant's papers. All applicants who receive a rating of 70 or more shall be deemed eligible. Whenever it may be necessary, in order to supply qualified persons for appointment, the board may at any time between January 1 and July 1 rate all applicants whose applications may be at such time on file and unrated.

9. As soon as the board has completed the rating of applicants for any period, as provided in section 8 of these regulations, it shall enter upon the register of eligibles the names of all those whom it has determined, in accordance with said section, to be eligible for the performance of mere manual labor, arranged in the order of relative fitness, with the highest first: *Provided*, That the names of eligibles who are entitled to preference under section 1754 of the Revised Statutes shall be placed at the head of the register in the order of their ratings. Separate registers of eligibles shall be kept, one for males and one for females.

The period of eligibility shall be one year from the date on which the name of an eligible is entered on the register.

10. Whenever the Secretary of Agriculture desires to fill, by original appointment, an existing vacancy in the position of mere manual laborer, upon his request the board of labor employment shall certify to him from the male or female register, as indicated in the request, the three names at the head thereof which have not been three times certified. Of the three names certified the Secretary of Agriculture shall select one for appointment, and if, at the time of the selection, there are more vacancies than one, he may select more than one. The policy of the Department will be to select for appointment the highest of the three names certified, unless, for some reason satisfactory to the Department, it is deemed best to select one of the others. A person selected for appointment shall receive a certificate for a probationary period of six months, at the end of which period, if his conduct and capacity are satisfactory to the Secretary of Agriculture, his retention in the service shall be equivalent to his absolute appointment; but if his conduct or capacity be not satisfactory, he shall be notified that he will not receive absolute appointment because of such unsatisfactory conduct or want of capacity, and such notification shall discharge him from the service. Removal during the probationary period or after absolute appointment shall be made without any regard to political or religious affiliations. Whenever a person is separated from the position of mere manual laborer for any reason, he shall be given what may be known as a separation card, upon which shall be entered a statement of the reasons for his separation and of the character of service rendered by him.

11. Persons appointed through certification by the board of labor employment under these regulations shall not be assigned to the performance of any clerical duty or of any duty properly belonging to any position classified under the civil-service law; and the compensation paid to any person appointed under these regulations shall not exceed fifty dollars per month or six hundred dollars per annum.

12. The records of the board of labor employment shall at all times be open to the inspection of the Civil Service Commission or its authorized representatives.

13. In connection with his monthly report of changes to the Commission the Secretary of Agriculture shall certify whether any person holding a position of mere manual laborer under these regulations has been assigned to clerical duty or any other duty properly belonging to a position classified under the civil-service law.

14. The Civil Service Commission, whenever it shall find that any person is holding a position contrary to the provisions of these regulations, shall, after notice to the person affected and an opportunity for explanation or other statement, certify information of the fact of such irregularity to the Secretary of Agriculture, and then if such person be not dismissed within thirty days, to the disbursing and auditing officers through whom the salary or wages of such person is by law required to be paid; and thereafter such disbursing or auditing officers shall not pay or permit to be paid to such person any salary or wages which accrue after such certificate has been received by him.

15. These regulations may be amended either by the President or by the concurrent action of the Secretary of Agriculture and the Civil Service Commission.

THEODORE ROOSEVELT, *President.*
JAMES WILSON, *Secretary of Agriculture.*

Dated July 2, 1902.

AMENDED REGULATIONS GOVERNING APPOINTMENTS OF MERE UNSKILLED LABORER UNDER DEPARTMENT OF AGRICULTURE IN DISTRICT OF COLUMBIA.

Regulation 9 amended.

Section 9 of the regulations governing appointment to positions of mere unskilled laborer under the Department of Agriculture in the District of Columbia is hereby amended by inserting after the word "males" the words "between the ages of fourteen and twenty-one years, and one for males between the ages of twenty-one and sixty-five years," and add after the word "females" the following words: "between the ages of fourteen and twenty-one years, and one for females between the ages of twenty-one and sixty-five years," so that the section will read as follows when so amended:

"9. As soon as the board has completed the ratings of applicants for any period, as provided in section 8 of these regulations, it shall enter upon the

register of eligibles the names of all those whom it has determined, in accordance with said section, to be eligible for the performance of mere manual labor, arranged in the order of relative fitness, with the highest first: *Provided*, That the names of eligibles who are entitled to preference under section 1754 of the Revised Statutes shall be placed at the head of the register in the order of their ratings. Separate registers shall be kept—one for males between the ages of fourteen and twenty-one years, and one for males between the ages of twenty-one and sixty-five years, and one for females between the ages of fourteen and twenty-one years, and one for females between the ages of twenty-one and sixty-five years. The period of eligibility shall be one year from the date on which the name of an eligible is entered on the register."

(Signed) JAMES WILSON.
Secretary of Agriculture.

(Signed) W. D. FOULKE.
Acting President U. S. Civil Service Commission.

AUGUST 29, 1902.

Regulation 10 amended.

Section 10 of the regulations governing appointment to positions of mere unskilled laborer under the Department of Agriculture in the District of Columbia is hereby amended by adding after the words "Whenever the Secretary of Agriculture desires to fill, by original appointment, an existing vacancy in the position of mere manual laborer," the following words: "in some specified bureau, division, or office;" and by adding after the words "upon his request the board of labor employment shall certify to him from the male or female registers, as indicated in the request, the three names at the head thereof which have not been three times certified," the words "to such specified bureau, division, or office;" so that the section, as amended, shall read as follows:

"10. Whenever the Secretary of Agriculture desires to fill, by original appointment, an existing vacancy in the position of mere manual laborer in some specified bureau, division, or office, upon his request the board of labor employment shall certify to him from the male or female registers, as indicated in the request, the three names at the head thereof which have not been three times certified to such specified bureau, division, or office. Of the three names certified the Secretary of Agriculture shall select one for appointment, and if, at the time of the selection, there are more vacancies than one, he may select more than one. The policy of the Department will be to select for appointment the highest of the three names certified, unless, for some reason satisfactory to the Department, it is deemed best to select one of the others. A person selected for appointment shall receive a certificate for a probationary period of six months, at the end of which period, if his conduct and capacity are satisfactory to the Secretary of Agriculture, his retention in the service shall be equivalent to his absolute appointment; but if his conduct or capacity be not satisfactory, he shall be notified that he will not receive absolute appointment because of such unsatisfactory conduct or want of capacity, and such notification shall discharge him from the service. Removal during the probationary period or after absolute appointment shall be made without any regard to political or religious affiliations. Whenever a person is separated from the position of mere manual laborer for any reason, he shall be given what may be known as a separation card, upon which shall be entered a statement of the reasons for his separation and of the character of service rendered by him."

(Signed) JAMES WILSON.
Secretary of Agriculture.

(Signed) WM. D. FOULKE.
Acting President U. S. Civil Service Commission.

MARCH 31, 1903.

Regulation 6 amended by Executive order.

In the tests prescribed under regulations governing the employment of unskilled labor the element of age shall be omitted in the case of soldiers and sailors of the civil war, and their relative fitness decided by their physical qualifications, moral character, industry, and adaptability for manual labor.

THEODORE ROOSEVELT.

WHITE HOUSE.
Approved, July 8, 1903.

Regulation 2 amended.

No person shall be appointed to, or employed in, any position of mere laborer under the Department of Agriculture in the District of Columbia except in accordance with these regulations. But in an urgent emergency, when the work required to be done will admit of no delay and the services of a mere laborer are requested for a short period, a mere laborer may be employed, without reference to these regulations, for a period not in any case exceeding thirty days in any one calendar year, the same laborer not to be employed for a longer period than thirty days in any one calendar year.

JAMES WILSON,
Secretary of Agriculture.
ALFORD W. COOLEY,
Acting President Civil Service Commission.

SEPTEMBER 3, 1903.

GROWTH OF THE DEPARTMENT.

On September 30, 1861, the Agricultural Division of the Department of the Interior, being the immediate predecessor of the U. S. Department of Agriculture, consisted of nine persons.

The following shows the development of the force of the Department from September 30, 1863, to July 1, 1904:

1863, September 30	29	1891, July 1 (including the Weather Bureau, transferred on July 1, 1891)	1,577
1867, September 30	99	1893, July 1	1,870
1871, September 30	84	1895, July 1	2,043
1873, September 30	92	1897, July 1	2,444
1875, September 30	90	1899, July 1	2,965
1877, September 30	77	1900, November 16	3,128
1879, June 30	93	1901, July 1	3,388
1881, July 1	108	1902, July 1	3,789
1883, July 1	239	1903, July 1	4,200
1885, July 1	214	1904, July 1	4,504
1887, July 1	328		
1889, July 1	488		

The persons constituting the Weather Bureau were transferred to the U. S. Department of Agriculture from the United States Army on July 1, 1891. The Weather Bureau was created by "An act to increase the efficiency and reduce the expenses of the Signal Corps of the Army and to transfer the Weather Service to the Department of Agriculture," approved October 1, 1890.

EXTRACTS FROM LAWS, SHOWING APPROPRIATIONS FOR AGRICULTURE, 1838–1863.

[Volume 5, United States Statutes, chapter 188, page 302: "An act to encourage the introduction and promote the cultivation of tropical plants in the United States."]

Whereas in obedience to the Treasury circular of the sixth of September, eighteen hundred and twenty-seven, Doctor Henry Perrine, late American consul at Campeche, has distinguished himself by his persevering exertions to introduce tropical plants into the United States; and whereas he has demonstrated the existence of a tropical climate in southern Florida, and has shown the consequent certainty of the immediate domestication of tropical plants in tropical Florida, and the great probability of their gradual acclimation throughout all our southern and southwestern States, especially of such profitable plants as propagate themselves on the poorest soils; and whereas, if the enterprise should be successful, it will render valuable our hitherto worthless soils by covering them with a dense population of small cultivators and family manufacturers, and will thus promote the peace, prosperity, and permanency of the Union: Therefore,

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a township of land is hereby granted to Doctor Henry Perrine and his associates, in the southern extremity of the Peninsula of East Florida, to be located in one body of six miles square, upon any portion of the public lands below twenty-six degrees north latitude.

SEC. 2. *And be it further enacted*, That the said tract of land shall be located within two years from this date, by said Henry Perrine, and shall be surveyed under his direction by the surveyor of Florida: *Provided*, That it shall not embrace any land having sufficient quantities of naval timber to be reserved to the United States, nor any sites for maritime ports or cities.

SEC. 3. *And be it further enacted*, That whenever any section of land in said tract shall be really occupied by a bona fide settler, actually engaged in the propagation or cultivation of valuable tropical plants, and upon proof thereof being made to the Commissioner of the General Land Office, a patent shall issue to the said Henry Perrine and his associates.

SEC. 4. *And be it further enacted*, That every section of land in the tract aforesaid which shall not be occupied by an actual settler positively engaged in the propagation or cultivation of useful tropical plants within eight years from the location of said tract, or when the adjacent territory shall be surveyed and offered for sale, shall be forfeited to the United States.

Approved July 7, 1838.

[Volume 5, United States Statutes, chapter 88, section 9, page 354: "An act in addition to 'An act to promote the progress of the useful arts.'"]

SEC. 9. *And be it further enacted*, That a sum of money not exceeding one thousand dollars be, and the same is hereby, appropriated, out of the patent fund, to be expended by the Commissioner of Patents in the collection of agricultural statistics, and for other agricultural purposes; for which the said Commissioner shall account in his next annual report.

Approved March 3, 1839.

[United States Statutes at Large, volume 5, chapter 88, page 354.]

And be it further enacted, That a sum of money not exceeding one thousand dollars be, and the same is hereby, appropriated, out of the patent fund, to be expended by the Commissioner of Patents in the collection of agricultural statistics, and for other agricultural purposes; for which the said Commissioner shall account in his next annual report.

Approved March 3, 1839.

[Volume 5, chapter 202: "An act legalizing and making appropriations, &c.," sec. 26, page 533.]

For the collection of agricultural statistics, and for other agricultural purposes, one thousand dollars.

Approved August 26, 1842.

[Volume 5, chapter 100: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 642.]

PATENT OFFICE: For the collection of agricultural statistics, and for other agricultural purposes, to be paid out of the patent fund, two thousand dollars.

Approved March 3, 1843.

[Volume 5, chapter 105: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 687.]

PATENT OFFICE: For the collection of agricultural statistics, and for other purposes, two thousand dollars.

Approved June 7, 1844.

[Volume 5, chapter 71: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 737.]

PATENT OFFICE: For the collection [of] agricultural statistics, and other purposes, three thousand dollars, to be paid out of the patent fund.

Approved March 3, 1845.

No appropriation for the collection of agricultural statistics found in the act making appropriations for the civil and diplomatic expenses of Government in the year 1846.

[Volume 9, chapter 47: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 160.]

PATENT OFFICE: For the collection of agricultural statistics, and other purposes, three thousand dollars, to be paid out of the patent fund.

Approved March 3, 1847.

[Volume 9, chapter 156: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 285.]

PATENT OFFICE: For the collection of agricultural statistics, and other purposes, thirty-five hundred dollars, to be paid out of the patent fund.

Approved August 12, 1848.

[Volume 9, chapter 100: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 364.]

For the collection of agricultural statistics, and other purposes, thirty-five hundred dollars. For defraying the expenses of chemical analysis of vegetable substances produced and used for the food of man and animals in the United States, to be expended under the direction of the Commissioner of Patents, one thousand dollars, which several sums * * * shall be paid out of the patent fund.

Approved March 3, 1849.

[Volume 9, chapter 90: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 541.]

For the collection of agricultural statistics, four thousand five hundred dollars, to be paid out of the patent fund.

Approved September 30, 1850.

[Volume 9, chapter 32: "An act making appropriations for the civil and diplomatic expenses of Government, &c.," page 615.]

For the collection of agricultural statistics, five thousand five hundred dollars, to be paid out of the patent fund.

Approved March 3, 1851.

[Volume 10, chapter 108: "An act making appropriations for the civil and diplomatic expenses of the Government for the year ending the 30th of June, 1853, and for other purposes," page 95.]

For the collection of agricultural statistics, and for the purchase of seeds, to be paid out of the patent fund, five thousand dollars.

Approved August 31, 1852.

[Volume 10, chapter 97: "An act making appropriations for the civil and diplomatic expenses of Government for the year ending the 30th of June, 1854," page 208.]

For the collection of agricultural statistics, and purchase of seeds, to be paid out of the patent fund, five thousand dollars.

Approved March 3, 1853.

[Volume 10, chapter 60: "An act to supply deficiencies in the apropriations for the services of the fiscal year ending the 30th of June, 1854, and for other purposes," page 292.]

For the collection of agricultural statistics, and the procurement and distribution of seeds and cuttings, to be expended under the direction of the Commissioner of Patents, ten thousand dollars.

Approved May 31, 1854.

[Volume 10, chapter 242: "An act making appropriations for the civil and diplomatic expenses of Government for the year ending the 30th of June, 1855, and for other purposes," page 567.]

For the collection of agricultural statistics and the procurement and distributions of cuttings and seeds, twenty-five thousand dollars, to be paid out of any money in the Treasury not otherwise appropriated.

Approved August 4, 1854.

[Volume 10, chapter 175: "An act making appropriations for the civil and diplomatic expenses of Government for the year ending 30th of June, 1856, and for other purposes," page 664.]

For the collection of agricultural statistics and procuring and distributing cuttings and seeds, twenty-five thousand dollars.

Page 673: For the reimbursement of the Patent Office fund for moneys heretofore paid out by appropriations by acts of Congress for seeds and the collection of agricultural statistics, forty thousand seventy-eight dollars and seventy-eight cents, to be paid out of any moneys in the Treasury not otherwise appropriated.

Approved March 3, 1855.

[Volume 11, chapter 29: "An act to supply deficiencies of the appropriations for the services of the fiscal year ending the 30th of June, 1856," page 14.]

For the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement and distribution of cuttings and seeds, to be expended under the direction of the Commissioner of Patents, thirty thousand dollars.

Approved May 16, 1856.

[Volume 11, chapter 129: "An act making appropriations for certain civil expenses of the Government for the year ending the 30th of June, 1857," page 80.]

For the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement and distribution of cuttings and seeds, seventy-five thousand dollars, to be expended under the direction of the Commissioner of Patents.

Approved August 18, 1856.

[Volume 11, chapter 108: "An act making appropriations for certain civil expenses of the Government for the year ending the 30th of June, 1858," page 226.]

For the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement and distribution of cuttings and seeds, sixty thousand dollars, to be expended under the direction of the Commissioner of Patents; and to enable the Commissioner of Patents to collect and report information in relation to the consumption of cotton in the several countries of the world, three thousand five hundred dollars.

Approved March 3, 1857.

[Volume 11, chapter 154: "An act making appropriations for sundry civil expenses of the Government for the year ending the 30th of June, 1859," page 321.]

For collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement of cuttings and seeds, sixty thousand dollars: *Provided*, That it shall be the duty of the Commissioner of Patents to submit to the Secretary of the Interior, at the commencement of each session of Congress, invoices of seeds and cuttings purchased with the money hereby appropriated; and also a statement of expenses in procuring agricultural statistics, and incidental expenses in procuring seeds, cuttings, and information.

Approved June 30, 1858.

[Volume 11, chapter 82: "An act making appropriations for sundry civil expenses of the Government for the year ending the 30th of June, 1860," page 427.]

For collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement of cuttings and seeds, forty thousand dollars.

Approved March 3, 1859.

[Volume 12, chapter 211: "An act making appropriations for sundry civil expenses of the Government for the year ending the 30th of June, 1861," pages 198, 199.]

For collection of agricultural statistics, investigations for promoting agricultural and rural economy, and the procurement of cuttings and seeds, sixty thousand dollars.

Approved June 25, 1860.

[Volume 12, chapter 84: "An act making appropriations for sundry civil expenses of the Government for the year ending June 30, 1862," page 217.]

For collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement, propagation, and distribution of cuttings and seeds, sixty thousand dollars: *Provided, however*, That in the expenditure of this appropriation, and especially in the selection of cuttings and seeds for distribution, due regard shall be had to the purposes of general cultivation and the encouragement of the agricultural and rural interests of all parts of the United States.

Approved March 2, 1861.

[Volume 12, chapter 34: "An act making appropriations for sundry civil expenses of the Government for the year ending the 30th of June, 1863, and additional appropriations for the year ending the 30th of June, 1862," page 350.]

For collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement, propagation, and distribution of cuttings and seeds, of new and useful varieties, and for the introduction and protection of insectivorous birds, and for investigations to test the practicability of preparing flax and hemp as a substitute for cotton, sixty thousand dollars.

Approved March 1, 1862.

All the above appropriations were to be expended by the Patent Office.

The Department of Agriculture was established July 1, 1862, according to the provisions of an act to establish the Department of Agriculture, approved May 15, 1862, volume 12, chapter 72, pages 387, 388.

The persons constituting the Weather Bureau were transferred to the U. S. Department of Agriculture from the United States Army on July 1, 1891. The Weather Bureau was created by "An act to increase the efficiency and reduce the expenses of the Signal Corps of the Army, and to transfer the Weather Service to the Department of Agriculture," approved October 1, 1890.

REPORT OF THE EDITOR, DIVISION OF PUBLICATIONS.

U. S. Department of Agriculture,
Division of Publications,
Washington, D. C., September 20, 1904.

Sir: I have the honor to submit herewith, for your information and consideration, a report on the work of this Division for the fiscal year ended June 30, 1904, together with recommendations in regard to future operations.

Respectfully,

Geo. Wm. Hill,
Editor and Chief.

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR.

The work of this Division during the year has been marked by unusual activity, therein reflecting the growth and activity which have characterized the Department as a whole. The large number of publications issued last year—938—has been exceeded in 1904, the total number for this year being 972. Of this number, 379 were new publications, comprising nearly 22,000 pages of matter. The total number of copies of all publications issued during the year aggregated 12,421,386. The total number of requisitions for printing issued on the main office of the Government Printing Office was 1,278, and the requisitions for work done in the branch printing office numbered 3,446. The total number of requisitions, therefore, for printing—that is exclusive of requisitions for illustrations—was 4,724, representing over 15 separate pieces of work for every week day in the year.

INDICATIONS OF GROWTH OF THE DEPARTMENT PUBLISHING.

Marked evidence of the steady growth in the work of this Division is afforded by comparison of the average number of publications issued during the five years closing with the fiscal year 1904 and the five years immediately preceding. During the former the average number of publications issued annually was 748 plus, while for the five years ending with the close of the fiscal year 1899 the average number published was 431 plus. The total number of copies handled in the Document Section in each period is as follows: For five years ended June 30, 1904, 49,707,639, averaging slightly under 10 million copies annually, while for the five-year period ending June 30, 1899, the total number of copies handled was 33,729,220, averaging slightly under $6\frac{3}{4}$ millions.

Eloquent as are these comparisons, however, they do not emphasize sufficiently the increase in the duties imposed upon our small editorial force. A true comparison to determine the increase of the work imposed upon this force must be furnished by the amount of new matter edited from year to year. Comparison in this respect between the year ended June 30, 1904, and the year 1900 shows that this work has very much more than doubled; the amount of new matter edited in this Division for the fiscal year 1904 being, as stated above, nearly 22,000 pages, whereas for the fiscal year 1900 the new matter edited aggregated less than 11,000 pages. It is gratifying to report that while there has necessarily been an increase in the force and in the annual appropriations, this increase has been less proportionately than the increase in the work accomplished, a fact which probably affords the most convincing testimony to the businesslike manner in which the work is handled and to the indefatigable efforts of our employees.

The large amount of business involved in the disposition of the work represented by nearly 5,000 separate requisitions, exclusive of those handled in the Section of Illustrations, and the multiplication of accounts for the expenditures of five separate and distinct funds and the keeping of ledger accounts with every Bureau and Division authorized to call for printing, to say nothing of the endless detail involved in the administration of an office with a force of over 150 persons, made it absolutely necessary for the relief of the Chief of the Division and his principal assistant that a chief clerk should be appointed. Fortunately your recommendation to this effect was favorably acted upon by Congress, and accordingly on the 1st of July last Mr. A. I. Mudd, formerly of the editorial staff, a gentleman having many years of business experience, was appointed to this place.

REPORTS ORDERED BY CONGRESS.

It should not be forgotten that, in addition to handling all the publishing covered by the regular appropriations made for the use of this Division and by the Department share of the general printing appropriation, there are a number of publications, and these generally publications of considerable size and consequence, regularly printed by enactment of Congress. Of those which are regularly provided for by law the cost is probably not less than $400,000, which sum forms a part of the expenditures of the Government Printing Office and is not charged against this Department. At almost every session, moreover, other publications are provided for by special resolutions. These, although not covered under any of the regular appropriations for the Department, form part, and a very important part, of the work of this Division.

The publications of this Department printed by order of Congress, including the special reports just referred to, were as follows:

PROVIDED FOR BY LAW.

(1) Annual reports of the Department of Agriculture for the fiscal year ended June 30, 1903, 6,000 copies.

(2) Yearbook of the Department of Agriculture, 1903, 500,000 copies.

(3) Nineteenth Annual Report of the Bureau of Animal Industry, for the year 1902, 30,000 copies.

(4) Annual Report of the Chief of the Weather Bureau, 1902–3, 4,000 copies.
(5) Annual Report of the Office of Experiment Stations for the year ended June 30, 1903, 5,000 copies.
(6) Field Operations of the Bureau of Soils, 1902, 17,000 copies.
(7) Letter from the Secretary of Agriculture, transmitting a statement of expenditures in that Department for the year ended June 30, 1903, 1,800 copies.
(8) Message from the President of the United States, transmitting a report by the Secretary of Agriculture relating to the operations of the Bureau of Animal Industry for the year ended June 30, 1903, 1,800 copies.

PROVIDED FOR BY SPECIAL RESOLUTION.

(1) Special Report on Diseases of the Horse, 200,000 copies.
(2) Progress of the Beet-Sugar Industry in the United States in 1903, 90,000 copies.

FARMERS' BULLETINS.

The number of Farmers' Bulletins printed during the year was 415, of which 25 were new publications, and the aggregate number of copies 6,435,000. In spite of every effort to keep down the cost of these publications, the amount expended slightly exceeded 1½ cents a copy, the limit which we have set as a fair average cost.

The Congressional distribution has far exceeded all previous years. The popularity of this class of publications among Senators and Representatives grows very rapidly. Very nearly 4,900,000 of them were distributed upon the orders of Senators and Representatives and Delegates, an excess over the previous year of 950,000. During the past three years this Congressional distribution has absorbed over 13,000,000 copies of Farmers' Bulletins alone, a number far exceeding the aggregate number so distributed up to that time; this notwithstanding that the appropriations for the Congressional distribution began with 1895. It is natural, therefore, that the bulk of the very small increase in the appropriations asked for for the use of this Division should come under the head of "Preparation, printing, and distribution of Farmers' Bulletins."

HOW TO EXPEDITE PUBLICATION WORK.

I feel compelled once more to urge upon Chiefs of Bureaus and Divisions the necessity of the prompt reading and return of proof. By order of the Secretary this work is required to be made very special, and yet this office experiences great difficulty in getting back proof of all kinds, even in cases where the author of the publication and his chief have urged that it be issued at the earliest possible date. Not infrequently the manuscript of a bulletin is submitted with the statement that its prompt publication is imperative, and yet when the proof is furnished it is not returned for weeks. Too often, if the author happens to be absent, proof is sent away, and much time is wasted over trivial matters of capitalization, punctuation, and style, which could safely be intrusted to this office, or in editing the matter when in type, against which practice also there exists an order of the Secretary. It can not be too strongly stated that the way to expedite publication work is to read the proof and return it in installments as soon as possible after receiving it. This course encourages the Printer to handle the work promptly, the general result being the completion and delivery of the work without the delays now too frequent. It need hardly be stated that manuscript should never be sub-

mitted until all statements of fact have been verified as completely as practicable, so that no changes will be required in the proof.

UNCLASSIFIED PAMPHLETS.

There has been a tendency of late toward the publication of pamphlets not numbered in any Department series, the reason advanced for not numbering them being that they are of temporary value and not of sufficient importance to be classed as publications. It is the opinion of this office that the practice should be discontinued and that the usual rule should be adhered to of giving a circular number or bulletin number to every pamphlet which is not of the nature of an office blank or instructions to correspondents. The series of circulars was adopted for all pamphlets, however small, which are designed for distribution, and the numbering of them as publications, for such they really are, affords a convenient and easy method of keeping account of them both in the Bureau or Division issuing them, in our own Document Section, and in the libraries of the country, and would be of great assistance to persons in applying for them.

PUBLICATIONS FOR EDUCATIONAL INSTITUTIONS.

One marked feature of the demands made upon the Department for publications during the last year has been the greatly increased number of requests coming from educational institutions, in which, perhaps, normal schools are in the lead, but embracing schools, academies, and colleges of every description. These demands have been complied with as far as possible, but promise to tax our resources very heavily, varying in number as they do from 40 to 50 copies for some special class to as many as 6,000 or 7,000 requested by State superintendents of schools for general distribution to teachers. The objects of this distribution, so obviously in line with the efforts of this Department as an educational force, eminently justify our earnest effort to comply with these requests. At the same time, the demand, being comparatively new and giving evidence of rapid growth, must be reckoned with in the disposal of our publications in the future. The opening up of this comparatively new field for the distribution of our documents emphasizes more strongly than ever the importance of avoiding waste by all means available. An earnest effort has been made to limit the initial distribution of publications, which comprises persons regularly supplied without awaiting their individual requests. This effort has been productive of good results, but has not yet reached far enough. It is my opinion that with the exception of public institutions connected with agricultural work, libraries and educational institutions which embrace agricultural topics in their curricula, and, of course, the press, no publications should be distributed save on the application of the individual, with the exception of the Monthly List, which should be very widely distributed, as it enables the recipients to apply for any particular bulletin or bulletins in which they may be specially interested. In spite of the fact that of the total number of copies of bulletins issued during the year over six millions were reprinted to meet continued demands, this Division is obliged to prepare scores of letters daily regretting its inability to comply with an applicant's request owing to the edition of this, that, or the other bulletin being exhausted.

DISPOSAL OF UNUSED CONGRESSIONAL QUOTAS OF PUBLICATIONS.

Another source from which our supply might be increased without additional expense may be found in the unused portion of Congressional quotas of those publications of which a portion is set aside for the use of Senators and Representatives. A very large proportion of these quotas remains unused for a year and sometimes for years after their issue. It has sometimes happened that Senators and Representatives have of their own motion turned back to this Department their quotas of such of its publications as they did not care to distribute, a courtesy which has been very highly appreciated; and it seems that some general provision of law might be adopted whereby a certain proportion of every unused quota of executive publications should, at the expiration of twelve months from issue, be made available for the use of the Department from which it emanated, or be turned over to the Superintendent of Documents in the same manner as is now done with the surplus publications of the several departments of the Government. The fact that all are alike interested in securing the distribution of all the publications issued by the Government at public expense to those who will use them to advantage will doubtless justify this suggestion to the minds of some who might be inclined on a first casual consideration to regard it as presumptuous. It may be well to state here in regard to Farmers' Bulletins, which furnish a larger supply of publications for the use of Senators and Representatives than any other publication of the Government, that few, if any, of them remain unused. Even when not desired for their own constituents, Senators and Representatives usually transfer their quotas to others who need them, so that the number of those making no call upon the Department for their share is very small, amounting during the past year to about 3 per cent. Moreover, the aggregate of Congressional quotas remaining uncalled for at the end of each fiscal year is turned over by your direction to the next year's supply to be used in assigning the quota for that year.

REPRINTING OF PUBLICATIONS BY SUPERINTENDENT OF DOCUMENTS.

In connection with the sale of our publications by the Superintendent of Documents, through whose courtesy a statement of the sales of the year is appended, it is very gratifying to report that the proposition made some years ago and concurred in by the Superintendent of Documents and the writer became a law in the second session of the present Congress by the adoption of Public Resolution No. 11, authorizing the reprinting of certain documents to be sold by the Superintendent of Documents, which concludes with the following words:

> And the Superintendent of Documents is hereby authorized to order reprinted from time to time such public documents as may be required for sale; such order for the reprinting to be subject to the approval of the Secretary or head of the Department in which the public document shall have originated: *Provided*, That the appropriation for printing and binding shall be reimbursed for the cost of such reprints from the moneys received by the Superintendent of Documents from the sale of public documents.

This provision can not fail to be particularly helpful in meeting a very much felt want by supplying the Superintendent of Documents with means whereby he can, without calling upon the funds of the Departments, be supplied with such of their publications as may be the subject of continuous demands on the part of the public.

ILLUSTRATIONS.

CURTAILMENT IN NUMBER.

In pursuance of your instructions, every effort has been made to limit the number of illustrations in new publications. A certificate has been required from every Chief to the effect that he has personally examined the illustrations submitted with the manuscript of every new publication and has confined the number asked for to such as he deems to be essentially necessary to an intelligent comprehension of the text by the reader. Even then it has been found possible sometimes upon consultation to still further restrict the number asked for, and the result has been that, notwithstanding the increase in the number of publications and in the total number of pages of new matter submitted for publication, the number of illustrations in the new publications has been reduced by considerably over 500, or more than 20 per cent, from the year previous.

ADDITIONAL FACILITIES.

The addition to the photographic equipment of the Section of Illustrations of the Division referred to in my last report was made just in time to prove of especial use during the latter part of the year covered by the present report. A table attached shows a very considerable increase in this line of work, the figures for which, however, fail to express fully the actual increase which has taken place, the fact being that the bulk of work done was accomplished in the latter half of the fiscal year. Demands for assistance of this character have been made upon the Division to an extent quite unprecedented. The increase in these demands, actually exceeding the increase in the facilities, fully justifies the expense incurred in developing our equipment and in increasing the force devoted to this work, and renders it extremely desirable that this development in our service continue until we have a photographic studio as completely equipped as any in the country. It must be remembered that expense incurred in this direction is true economy, readily appreciated by all who understand the extent to which the camera is relied upon as a supplement to and a substitute for the more expensive service of artists and draftsmen. In view of this growing responsibility and of the maintenance of our force of artists at a high degree of efficiency, the reorganization of this section under a responsible chief is urgently called for and will, I trust, be not long delayed.

THE DOCUMENT SECTION.

SUPERVISION OF THE DISTRIBUTION OF DOCUMENTS.

The distribution of public documents is regulated by section 92 of the act providing for the public printing and binding, etc., approved January 12, 1895, which reads as follows:

SEC. 92. Government publications printed for or received by the Executive Departments, whether for official use or for distribution, shall be distributed by a competent person detailed to such duty in each Department by the head thereof. He shall keep an account in detail of all of the publications received and distributed by him. He shall prevent duplication and make detailed report to the head of the Department, who shall transmit the same annually to Congress.

The Department Editor, who is also Chief of the Division of Publications, is charged with the supervision of the distribution of the Department's publications. In this work he has the help of an employee in the Weather Bureau, having the supervision of the distribution of Weather Bureau publications only, and an assistant in charge of the Document Section, who receives from the Public Printer and distributes all other publications issued by this Department.

WORK INVOLVED IN HANDLING THE PUBLICATIONS.

No better evidence of the great expansion and diversified activities which have characterized the Department under the administration of its present head can be found than in the increased work devolving upon this Division and in the demand made upon the force employed in the handling of the Government publications. The bare figures give indisputable testimony. In 1898, 4,438,130 publications were received and 5,388,147 distributed, while in the fiscal year just closed 10,717,408 were received and 11,733,684 were distributed.

To comply as fully as possible with the provisions of the law in distributing this large number of documents involves a great deal of labor; not only in actual handling, but in the attention to correspondence, the writing of franks, the keeping of card indexes to save duplication, and the preparing of registration franks for the more important books to insure correct delivery.

CORRESPONDENCE RELATING TO PUBLICATIONS.

In 1899 the total number of communications prepared and mailed from the Document Section was 136,832, of which 7,204 were signed letters and typewritten forms and 129,628 were notifications bearing the printed signature of the Chief of the Division: in 1904 the total number prepared and mailed was 247,142, of which 32,398 were signed letters and typewritten forms and 214,744 notifications having printed signatures of the Chief. This immense correspondence is necessary in order to carry out the policy that every communication received in the Document Section, in reference to publications, shall have a prompt personal reply.

The proper disposal of this correspondence requires considerable familiarity with the subjects treated in the numerous publications of the Department, and as many of the applications are for publications issued by some other Department and often for publications not Governmental, the work involves wide acquaintance not only with the

contents of Government publications generally, but with agricultural literature at large, so that reference may be made to the proper Department or the applicant put in the way to secure the information he desires from other sources. To assist in this work a former employee of the office of the Superintendent of Documents, who had acquired wide acquaintance with Departmental publications, has been secured and the office's service to the people at large in this line has been greatly strengthened.

When it is remembered that back of each of these communications is the labor involved in digesting the mail, making an order, writing the franks, filling the order, and entering upon the books of the Department the number of publications and the title of each forwarded, some idea may be formed of the amount of clerical, semiclerical, and manual work entailed upon the Document Section, which work is largely performed by persons, who, though hard working, painstaking, and deserving, are, by comparison with others in Government service, receiving but low salaries, and without much incentive from the hope of future promotions.

PREPARATION OF FRANKS FROM SPECIAL LISTS.

During the twelve months just ended additional work has been assigned to the Document Section from the various Bureaus, Divisions, and Offices of the Department, in the preparation of franks from extensive lists of persons engaged in special lines of agriculture, or from miscellaneous lists furnished by the different Divisions for particular publications of interest to persons engaged in a particular line of agricultural work.

RECORDS OF DOCUMENTS RECEIVED AND DISTRIBUTED.

The methods of bookkeeping and card indexing have been developed and improved, so that even with the immense amount of correspondence and the enormous distribution of widely different documents it is possible promptly to state just when any document was mailed to anyone, or how many of any publication are on any day in the possession of the Department. This has been done without any material addition within the last two years to the force employed there.

The number of the Department's publications which are now sent out by registered mail, and of which a card index of the persons to whom they are mailed is kept in order to prevent duplication, has been greatly increased. The Yearbooks, each of the annual reports of the various Bureaus, and all of the bulletins and special reports considered of sufficient importance to be furnished in other than paper bindings, are distributed under that system. It has been found such an efficient method of distribution, and the arrangements with the local post-office are so satisfactory, that it is proposed to extend still further this checking system, thereby saving to the Department many thousands of publications and to the Document Section much unproductive labor.

FARMERS' BULLETINS RECEIVED AND DISTRIBUTED.

On July 1, 1903, there were on hand 3,491,280 Farmers' Bulletins, and there have been received during the fiscal year ended June 30,

1904, 6,176,582, making a supply of 9,667,862. Of these, 4,895,556 were distributed under the orders of Senators, Representatives, and Delegates to their constituents, and 2,225,105 were mailed in reply to miscellaneous applications addressed directly to the Department, or a total of 7,120,661 Farmers' Bulletins distributed to the country during the fiscal year, leaving on hand 2,547,201.

BUREAU AND DIVISIONAL PUBLICATIONS RECEIVED AND DISTRIBUTED.

Of the publications of the Department other than Farmers' Bulletins, there were on July 1, 1903, 746,761 in the possession of the Department, and there were received from the Public Printer 4,540,826, making a total of 5,287,587, of which 4,713,023 were distributed, leaving a balance of 574,564. This leaves a total balance 1,116,276 less than was on hand one year ago, or in other words that many of the older publications have been requested of and distributed by the Department among the citizens of the United States interested in agriculture.

PERSONNEL OF THE DIVISION.

The personnel of the Division of Publications as it existed July 1, 1904, included besides the Editor, the Associate Editor, and the Chief Clerk, officials whose duties are of a general character, 143 persons assigned to special lines of work, as follows: In the editorial section, 8; in the business office, 5; in the illustration section, 10, and in the document section, 120. In addition to these there were detailed from the force of this Division for special duty in the Office of the Secretary and of some other Bureaus and Divisions, 17 persons; on the other hand there were at that time 6 persons detailed from other Bureaus and Divisions at work in the Division of Publications. It is gratifying to me to be able to report continued improvement in the personnel of the force. In fidelity to duty and efficiency in work performed, the force of this Division compares favorably with the force of any other Bureau or Division in the service. The best evidence of this is to be found in the fact that the constant increase in the amount of work accomplished is far larger than the increase in the force or in the appropriations. This state of things could not exist without the hearty, cheerful, and intelligent cooperation of the great bulk of the force.

DESIRABILITY OF CHANGE IN ORGANIZATION.

The work accomplished during the year has served to emphasize in a marked degree the desirability of a change in the organization of the Division, recognized in your estimates for the current year and granted in part by Congress. Some further details in the organization are now imperatively necessary, especially such as will recognize the increased responsibility unavoidably thrown on my principal assistants, as well as afford some acknowledgment of the loyal and efficient manner in which their work has been performed.

ADDITIONAL ACCOMMODATIONS.

It is proper that I should gratefully acknowledge the earnest effort of the Chief Clerk of the Department to supply the additional accom-

modations made so necessary by the increase of work. Thanks to his care in this matter, this Division will this year, when the arrangements now being made for its accommodation are completed, be, for the first time, fairly provided for. While the vexation and extra work entailed by the dispersion of our force in separate buildings and in sections of the same building remote for each other still continue, this must be recognized as a condition inseparable from the lack of accommodation the Department as a whole has to suffer, and which can be remedied only by the completion of a new and adequate building.

STATISTICS OF PUBLICATION WORK.

The details of the publication work of the Department are given in the following tables:

Number and classes of publications issued in the fiscal year 1904.

Publications—	
Chargeable to regular printing fund	442
Chargeable to divisional funds	26
Chargeable to Farmers' Bulletin fund	415
Printed as executive documents	10
Edited at Weather Bureau	79
Total	972

Number of publications, original and reprint, and number of pages and copies of each class, fiscal years 1901, 1902, 1903, and 1904.

Character of publication.	1901.			1902.		
	Number of publications.	Pages.	Copies.	Number of publications.	Pages.	Copies.
Original	262	14,656	3,903,094	355	18,184	4,009,136
Reprint	232	9,139	3,115,600	317	12,454	5,791,040
Weather Bureau	112	3,341	880,587	85	664	786,404
Total	606	27,136	7,899,281	757	31,302	10,586,580

Character of publication.	1903.			1904.		
	Number of publications.	Pages.	Copies.	Number of publications.	Pages.	Copies.
Original	375	21,262	4,583,225	379	21,647	5,470,236
Reprint	482	21,912	6,295,000	514	15,018	6,111,300
Weather Bureau	81	1,831	820,339	79	1,241	839,850
Total	938	45,005	11,698,564	972	37,906	12,421,386

Number of publications issued from 1894 to 1904, by years.

Year.	Number of publications.	Total number of copies.	Year.	Number of publications.	Total number of copies.
1894	205	3,169,310	1901	606	7,899,281
1895	254	4,100,660	1902	757	10,586,580
1896	376	6,561,700	1903	938	11,698,564
1897	424	6,541,210	1904	972	12,421,386
1898	501	6,280,365			
1899	603	7,075,975	Total	6,104	83,487,459
1900	468	7,152,428			

Number of publications, original and reprint, and pages by Bureaus, Divisions, and Offices, fiscal year 1904

Bureaus, Divisions, and Offices.	Publications.			Pages.			Number of copies.		
	Original.	Reprint.	Total.	Original.	Reprint.	Total.	Original.	Reprint.	Total.
Secretary's Office	11	5	16	603	131	734	97,500	47,500	145,000
Executive documents	10	.....	10	5,314	.....	5,314	855,000	.....	855,000
Accounts and Disbursements	1	.....	1	22	.....	22	200	.....	200
Animal Industry	40	105	145	1,942	3,577	5,519	316,136	1,482,500	1,798,636
Biological Survey	11	20	31	1,159	585	1,744	74,000	82,500	156,500
Chemistry	15	15	30	889	1,280	2,169	26,750	77,650	104,400
Entomology	26	41	67	1,043	1,266	2,309	155,250	405,950	561,200
Experiment Stations	108	130	238	5,560	1,695	7,255	402,500	1,685,200	2,087,700
Forestry	11	23	34	284	1,152	1,436	117,000	200,000	317,000
Library	6	.....	6	240	.....	240	5,200	.....	5,200
Plant Industry	39	119	158	1,593	3,398	4,991	372,500	1,443,500	1,816,000
Publications	19	23	42	387	823	1,210	1,479,000	290,500	1,769,500
Public Road Inquiries	5	22	27	133	717	850	59,000	238,000	297,000
Soils	42	6	48	900	265	1,165	78,300	30,500	108,800
Statistics	31	4	35	1,503	101	1,604	1,425,200	112,500	1,537,700
Weather Bureau[a]	83	1	84	1,316	28	1,344	845,950	15,000	860,950
Total	458	514	972	22,888	15,018	37,906	6,310,089	6,111,300	12,421,386

[a] Edited at Weather Bureau: Publications, 79; pages, 1,241; copies, 839,850.

Amount expended for the various Bureaus, Divisions, and Offices for printing and binding, 1904.

Division of Accounts and Disbursements	$1,969.62
Bureau of Animal Industry	16,309.50
Division of Biological Survey	3,210.85
Bureau of Chemistry	4,915.16
Division of Entomology	4,500.79
Office of Experiment Stations	30,803.48
Bureau of Forestry	3,700.53
Library	7,462.56
Bureau of Plant Industry	21,666.85
Division of Publications	2,821.10
Office of Public Road Inquiries	3,107.10
Bureau of Soils	2,625.08
Bureau of Statistics (including Foreign Markets $5,271.08)	18,867.29
Miscellaneous	5,695.38
Printing at branch printing office for the various Bureaus, Divisions, and Offices	28,860.09
Total	156,465.38

Farmers' Bulletins issued, 1899–1904, by years.

Originals and reprints of Farmers' Bulletins.	Number of bulletins.	Number of copies.
Fiscal year 1904:		
Originals	25	775,000
Reprints	390	5,660,000
Total	415	6,435,000
Fiscal year 1903:		
Originals	22	725,000
Reprints	301	5,877,000
Total	323	6,602,000
Fiscal year 1902:		
Originals	23	575,000
Reprints	236	5,575,000
Total	259	6,150,000

Farmers' Bulletins issued, 1899–1904, by years—Continued.

Originals and reprints of Farmers' Bulletins.	Number of bulletins.	Number of copies.
Fiscal year 1901:		
Originals	14	415,000
Reprints	157	2,930,000
Total	171	3,345,000
Fiscal year 1900:		
Originals	18	525,000
Reprints	90	1,835,000
Total	108	2,360,000
Fiscal year 1899:		
Originals	22	520,000
Reprints	154	1,917,000
Total	176	2,437,000

Cost of printing Farmers' Bulletins, 1900–1904.

Year.	Number of bulletins.	Number of copies.	Cost.
Fiscal year 1904:			
Paid from Farmers' Bulletin fund	415	6,435,000	$104,787.68
Fiscal year 1903:			
Paid from Farmers' Bulletin fund	323	6,602,000	95,534.18
Fiscal year 1902:			
Paid from Farmers' Bulletin fund	259	6,150,000	107,363.05
Fiscal year 1901:			
Paid from Farmers' Bulletin fund	171	3,345,000	51,796.68
Fiscal year 1900:			
Paid from Farmers' Bulletin fund	97	2,150,000	30,665.15
Paid from general printing fund	11	210,000	3,469.69
Total	108	2,360,000	34,134.84

New Farmers' Bulletins issued during the fiscal year 1904.

No. of bulletin.	Title of bulletin.	Total number of copies.
178	Insects Injurious in Cranberry Culture	20,000
179	Horseshoeing	30,000
180	Game Laws for 1903	30,000
181	Pruning	35,000
182	Poultry as Food	30,000
183	Meat on the Farm: Butchering, Curing, and Keeping	30,000
184	Marketing Live Stock	30,000
185	Beautifying the Home Grounds	30,000
186	Experiment Station Work—XXIII	30,000
187	Drainage of Farm Lands	30,000
188	Weeds Used in Medicine	35,000
189	Information Concerning the Mexican Cotton Boll Weevil	50,000
190	Experiment Station Work—XXIV	30,000
191	The Cotton Bollworm: An account of the Insect, with Results of Experiments in 1903	25,000
192	Barnyard Manure	30,000
193	Experiment Station Work—XXV	30,000
194	Alfalfa Seed	30,000
195	Annual Flowering Plants	50,000
196	Usefulness of the American Toad	20,000
197	Importation of Game Birds and Eggs for Propagation	30,000
198	Strawberries	30,000
199	Corn Growing	30,000
200	Turkeys: Standard Varieties and Management	30,000
201	The Cream Separator on Western Farms	30,000
202	Experiment Station Work—XXVI	30,000
	Total	775,000

Farmers' Bulletins contributed by Bureaus, Divisions, and Offices, 1904.

Bureaus, Divisions, and Offices.	New.	Reprints.	Number of copies.
Bureau of Animal Industry	5	90	1,585,000
Division of Biological Survey	2	4	125,000
Bureau of Chemistry	.....	6	70,000
Division of Entomology	4	27	500,000
Office of Experiment Stations	7	116	1,875,000
Bureau of Forestry	.....	8	130,000
Bureau of Plant Industry	7	104	1,655,000
Division of Publications	.....	22	290,000
Office of Public Road Inquiries	.....	10	165,000
Bureau of Soils	.....	2	25,000
Weather Bureau	.....	1	15,000
Total	25	390	6,435,000

Number of copies of Farmers' Bulletins issued (Nos. 1 to 202) and number distributed to members of Congress, 1894–1904.

Date.	Total number of copies issued.	Congressional distribution.	Date.	Total number of copies issued.	Congressional distribution.
Prior to 1894	540,000	.....	In 1900	2,360,000	1,666,909
In 1894	278,500	.....	In 1901	3,345,000	2,195,010
In 1895	1,567,000	885,770	In 1902	6,150,000	4,289,126
In 1896	1,891,000	1,316,695	In 1903	6,602,000	3,954,976
In 1897	2,387,000	1,967,237	In 1904	6,435,000	4,895,556
In 1898	2,170,000	1,580,065			
In 1899	2,437,000	1,101,985	Total	36,162,500	23,853,329

New Farmers' Bulletins issued each year from 1895 to 1904, inclusive.

Year.	Number of bulletins.	Year.	Number of bulletins.
In 1895	11	In 1901	14
In 1896	13	In 1902	23
In 1897	16	In 1903	22
In 1898	21	In 1904	25
In 1899	22		
In 1900	18	Total	185

Appropriations for the fiscal years 1903–1905.

Appropriation.	1903.	1904.	1905.
Statutory roll	$28,820	$29,320	$30,640
General printing fund	[a] 155,000	[b] 160,000	[b] 160,000
Preparation, printing, and distribution of Farmers' Bulletins	107,500	105,000	105,000
Additional assistants, artists, draftsmen, etc	12,500	10,000	15,000
Labor, material, wagons, horses, rent of building, etc	[c] 84,000	85,000	90,000
Total	387,820	389,320	400,640

[a] Exclusive of $20,000 for Weather Bureau.
[b] Exclusive of $25,000 for Weather Bureau.
[c] Including a deficiency of $4,000.

Expenditures under general appropriations for fiscal year ended June 30, 1904.

General printing fund	$156,466.38
Preparation and printing of Farmers' Bulletins	104,787.68
Additional assistants, artists, draftsmen, etc	9,992.51
Labor, material, etc	84,747.09
Total	355,993.66

Expenditures for printing and binding, total and by funds, 1904.

TOTAL EXPENDITURES.

Divisional publications paid from general fund	$106,012.45
Divisional publications paid from special funds	12,111.75
Blank books, blank forms, etc., paid from general fund	21,592.84
Blank books, blank forms, etc., paid from special funds	480.00
Branch office (all work) paid from general fund	28,860.09
Farmers' Bulletins paid from Farmers' Bulletin fund	93,902.36
Total	262,959.49

EXPENDITURES BY FUNDS.

General printing fund ($130,000, exclusive of $25,000 for Weather Bureau):		
Expended for the various Bureaus, Divisions, and Offices	$127,605.29	
Expended for printing at branch office for the various Bureaus, Divisions, and Offices	28,860.09	
		$156,465.38
Farmers' Bulletin fund		93,902.36
Divisional funds:		
Bureau of Animal Industry		643.60
Division of Biological Survey		25.00
Office of Experiment Stations		2,944.40
Bureau of Forestry		8,313.35
Bureau of Statistics		665.40
Total		262,959.49

Expenditures from the special funds of the Division.

Expenditures from the special appropriation of this Division, $10,000, for additional assistants, pay of artists and draftsmen, artists' supplies, etc.:	
Illustrating, including pay of artists	$8,321.09
Artists' supplies	772.02
Pay of additional assistants, purchase of manuscripts, etc	899.40
Total	9,992.51
From fund, $85,000, for labor and material in the distribution of documents, etc.:	
Labor in distribution of documents	71,457.49
Materials for document section	11,889.60
Rent for building for storage and distribution of Farmers' Bulletins	1,400.00
Total	84,747.09
From fund for preparation and printing Farmers' Bulletins:	
Preparation of Farmers' Bulletins	10,885.32
Printing Farmers' Bulletins	93,902.36
Total	104,787.68
Grand total	199,527.28

Requisitions on the main printing office, by Bureaus, Divisions, Offices, etc., 1904.

Secretary's Office	1
Division of Accounts and Disbursements	76
Bureau of Animal Industry	185
Division of Biological Survey	30
Bureau of Chemistry	51
Division of Entomology	58
Office of Experiment Stations	284
Division of Foreign Markets	8
Bureau of Forestry	96
Library	50
Bureau of Plant Industry	270
Division of Publications	48
Office of Public Road Inquiries	32
Bureau of Soils	23
Bureau of Statistics	37
Weather Bureau	5
Miscellaneous	24
Total	1,278

Publications printed in the branch printing office, 1904.

Bureaus, Divisions, and Offices.	Requisitions.	Number of copies printed.
Bureau of Animal Industry	8	47,000
Division of Biological Survey	6	9,500
Bureau of Chemistry	2	7,650
Division of Entomology	10	20,500
Office of Experiment Stations	14	24,500
Bureau of Forestry	11	52,000
Bureau of Plant Industry	3	7,500
Division of Publications	18	1,551,500
Office of Public Road Inquiries	2	14,000
Bureau of Soils	3	10,000
Bureau of Statistics	6	3,000
Miscellaneous	2	86,000
Total	80	1,789,150

Total work done in the branch printing office, 1904.

Envelopes	1,856,685
Letter heads and note heads	1,072,620
Cards	3,707,322
Circulars	709,597
Blanks	4,680,461
Labels and shipping tags	1,020,483
Franks	993,450
Monthly and other lists	1,278,205
Crop Reporter (reprints)	3,000
Circular letters and other notices	402,527
Miscellaneous	1,523,025
Total	17,285,375
Number of requisitions, 1904	3,440
Number of requisitions, 1903	3,350
Number of pieces of work, 1903	16,051,630

The composition of 12 editions of the Crop Reporter, 8 quarto pages each, was done in the branch printing office.

Requisitions on the branch printing office, by Bureaus, Divisions, Offices, etc., 1904.

Secretary's Office	3
Division of Accounts and Disbursements	81
Bureau of Animal Industry	344
Division of Biological Survey	96
Bureau of Chemistry	165
Division of Entomology	149
Office of Experiment Stations	376
Division of Foreign Markets	10
Bureau of Forestry	171
Library	73
Bureau of Plant Industry	975
Division of Publications	262
Office of Public Road Inquiries	46
Bureau of Soils	85
Bureau of Statistics	381
Miscellaneous	229
Total	3,446

Illustration work, 1904.

Drawings, retouching photographs, photographing on wood, etc	2,312
Requests for duplicate electrotypes	247
Duplicate electrotypes furnished to correspondents on request	1,880
Requisitions and authorizations	227
Illustrations printed or published (not including reprints)	2,041
Negatives made	477
Silver prints for pen drawings	189
Velox and albuma prints	1,816
Films developed	895
Bromide enlargements	84
Platinum prints	220
Blueprints	381
Mounting prints for reproduction	890
Lantern slides	194
Large transparencies	19
Artists' salaries	$8,076.96
Artists' supplies	772.02
Total	8,848.98

Number of publications sold by the Superintendent of Documents and amount received, 1900–1904.

Department.	Copies of publications sold.					Amount received.				
	1904.	1903.	1902.	1901.	1900.	1904.	1903.	1902.	1901.	1900.
Department of Agriculture	31,860	30,038	25,279	24,127	16,905	$4,309.60	$4,200.35	$3,551.91	$3,220.25	$2,157.65
All other Departments	15,940	11,048	9,932	9,458	10,998	8,296.57	7,435.69	7,394.30	6,862.44	6,744.56
Total	47,800	41,086	35,211	33,585	27,903	12,606.17	11,636.04	10,946.21	10,082.69	8,902.21

APPENDIX A.

PUBLICATIONS ISSUED DURING THE YEAR ENDED JUNE 30, 1904.

[The following publications were issued during the year ended June 30, 1904. Those to which a price is attached, with the exception of publications of the Weather Bureau, must be obtained of the Superintendent of Documents, Government Printing Office, Washington, D. C., to whom are turned over all copies not needed for official use, in compliance with section 67 of the act providing for the public printing and binding and the distribution of public documents. Remittances should be made to him by postal money order. Weather Bureau publications to which a price is attached must be obtained from the Chief of that Bureau. Applications for those that are for free distribution should be made to the Secretary of Agriculture, Washington, D. C.]

OFFICE OF THE SECRETARY.

	Copies.
Progress of the Beet-Sugar Industry in the United States in 1902. Pp. 221, pls. 5, figs. 65. Report No. 74. September 12, 1903. Price, 20 cents	1,000
Report of the Secretary of Agriculture. 1903. Pp. 106. December 1, 1903	5,000
Report of the Secretary of Agriculture. 1903. Pp. 99. Report No. 76. December 9, 1903	50,000
Standards of Purity for Food Products. Pp. 13. Circular No. 10. December 9, 1903	6,000
Report of the Appointment Clerk for 1903. By J. B. Bennett. Pp. ii, 461–482. December 26, 1903	500
Reprint, February 1, 1904	500
Indian Corn in Argentina: Production and Export. By Frank W. Bicknell, Special Agent. Pp. 48, pls. 7. Report No. 75. January 23, 1904. Price, 10 cents	10,000
Sugar-Beet Pulp as Animal Food. By Charles F. Saylor, Special Agent. Pp. 37–70. (From Report No. 74, Progress of the Beet-Sugar Industry in 1902.) (Reprint.) February 27, 1904	5,000
Reprint, March 31, 1904	1,000
Single-Germ Beet Balls and Other Suggestions for Improving Sugar-Beet Culture. Pp. 12. (From Report on Progress of Beet-Sugar Industry in 1902.) (Reprint.) April 6, 1903	1,000
Methods and Benefits of Growing Sugar Beets. By Charles F. Saylor, Special Agent for the Investigation of the Sugar Industry. Pp. 27. Circular No. 11. April 8, 1904	10,000
Reprint, May 5, 1904	40,000
An Enemy of the Cotton Boll Weevil. By O. F. Cook, Botanist in charge of Investigations in Tropical Agriculture, Bureau of Plant Industry. Pp. 7. Report No. 78. May 27, 1904	8,500
Alfalfa and Beef Production in Argentina. By Frank W. Bicknell, Special Agent. Pp. 32, pls. 6, figs. 5. Report No. 77. June 2, 1904	3,500
Some Soil Problems for Practical Farmers. By E. C. Chilcott, Professor of Geology and Agronomy in the South Dakota Agricultural College. Pp. iii, 441–452. (From Yearbook of Department of Agriculture for 1903.) June 9, 1904	1,400
Macaroni Wheat. By James H. Shepard, Chemist, South Dakota Experiment Station. Pp. iii, 329–336. (From Yearbook of Department of Agriculture for 1903.) June 11, 1904	2,000

CONGRESSIONAL.

	Copies.
Nineteenth Annual Report of the Bureau of Animal Industry, for the Year 1902. Pp. 651, pls. 64, map. October 24, 1903. Price, cloth, $1.10; paper, 95 cents	30,000
Special Report on Diseases of the Horse. By Drs. Pearson, Michener, Law, Harbaugh, Trumbower, Liautard, Holcombe, Huidekoper, Stiles, and Adams. Pp. 600, pls. 41, figs. 18. Bureau of Animal Industry, revised edition. November 28, 1903. Price, 65 cents	200,000
Field Operations of the Bureau of Soils, 1902. [Fourth Report.] By Milton Whitney, Chief. With accompanying papers by Assistants in Charge of Field Parties. Pp. 842, pls. 60, figs. 25, maps 44, in case. December 22, 1903. Price, $3.80	17,000
Annual Reports of the Department of Agriculture for the Fiscal Year ended June 30, 1903. Report of the Secretary of Agriculture. Departmental Reports. Pp. cviii, 1–560. January 19, 1904	6,000
Letter from the Secretary of Agriculture transmitting a Statement of Expenditures in that Department for the Year ended June 30, 1903. Pp. 436. (House Doc. No. 34. 58th Cong., 1st sess.) February 2, 1904	1,800
Message from the President of the United States transmitting a Report by the Secretary of Agriculture Relating to the Operations of the Bureau of Animal Industry for the Year ended June 30, 1903. (House Doc. No. 384. 58th Cong., 2d sess.) Pp. 139. April 6, 1904	1,800
Progress of the Beet-Sugar Industry in the United States in 1903. By Charles F. Saylor, Special Agent. Pp. 184. May 11, 1904	90,000
Yearbook of the U. S. Department of Agriculture, 1903. Pp. 728, pls. 65, figs. 54. May 18, 1904. Price, 75 cents	500,000
Annual Report of the Office of Experiment Stations for the Year ended June 30, 1903. Pp. 758, pls. 60. June 17, 1904	5,000
Annual Report of the Chief of the Weather Bureau, 1902–1903. Pp. 308. Quarto, cloth. June 28, 1904	4,000

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

Report of the Division of Accounts and Disbursements for 1903. By F. L. Evans. Pp. iii, 349–367. (From Annual Reports, Department of Agriculture.) December 11, 1903	200

BUREAU OF ANIMAL INDUSTRY.

The Duration of the Life of the Tubercle Bacillus in Cheese. By F. C. Harrison, Agricultural College, Guelph, Ontario. Pp. ii, 217–233. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) July 9, 1903	5,000
Distribution and Magnitude of the Poultry and Egg Industry. By George Fayette Thompson, M. S., Editor, Bureau of Animal Industry. Pp. ii, 149–213. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) (Reprint.) July 11, 1903	2,500
Feeding Fat into Milk; Or the Effect of the Food Upon the Quality and Quantity of Milk Produced. Recent Experimental Inquiry Upon Milk Secretion. By Chas. D. Woods, B. S. The Physiology of Milk Secretion. By A. W. Bitting, M. D. Pp. iii, 234–273. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) July 11, 1903	8,000
Statistics of Oleomargarine, Oleo Oil, and Filled Cheese, 1900 to 1902. Compiled by R. A. Pearson, M. S., Assistant Chief of Dairy Division, Bureau of Animal Industry. Pp. iii, 274–292. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) July 11, 1903	1,000
Index-Catalogue of Medical and Veterinary Zoology. [Authors: D to Dziembowski.] By Ch. Wardell Stiles, Ph. D., Consulting Zoologist of Bureau of Animal Industry, Zoologist of U. S. Public Health and Marine-Hospital Service, and Albert Hassall, M. R. C. V. S., Veterinary Inspector, Bureau of Animal Industry. Pp. 325–402. Bulletin No. 39. Part 4. July 22, 1903. Price, 5 cents	2,000

Copies.

The Milk Supply of Two Hundred Cities and Towns. By Henry E. Alvord, C. E., Chief of Dairy Division, and R. M. Pearson, M. S., Assistant Chief of Dairy Divison. Pp. 210. Bulletin No. 46. July 27, 1903. Price, 15 cents 11,000

The American Saddle Horse. By Gen. John B. Castleman, Louisville, Ky. Pp. iii, 62–78, pls. 5. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) August 17, 1903 1,000

Reprint, September 28, 1903 1,000

Foot-and-Mouth Disease. By D. E. Salmon, D. V. M., Chief of Bureau of Animal Industry. Pp. iv, 391–410, pls. 13, map. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) August 24, 1903 3,000

Reprint, October 31, 1903 3,000

The Tuberculin Test of Cattle in Great Britain. Results of Tests Made by the Bureau of Animal Industry on Cattle Offered for Exportation to the United States. By D. E. Salmon, D. V. M., Chief of Bureau of Animal Industry. Pp. 550–553. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) August 27, 1903 500

The Cold Curing of Cheese. Report Upon Experiments Conducted Under the Auspices of the U. S. Department of Agriculture, Bureau of Animal Industry, Dairy Division, in Cooperation with the Wisconsin Agricultural Experiment Station and the New York Agricultural Experiment Station. By S. M. Babcock and H. L. Russell, Assisted by U. S. Baer, Madison, Wis., and L. L. Van Slyke, G. A. Smith, and E. B. Hart, Geneva, N. Y. Pp. 88, pls. 4, figs. 22. Bulletin No. 49. September 9, 1903. Price, 10 cents 10,000

Takosis, A Contagious Disease of Goats. A Preliminary Report on its Nature, Cause, and Prevention. By John R. Mohler, V. M. D., A. M., Chief of Pathological Division, Bureau of Animal Industry, and Henry J. Washington, D. V. S., Acting Assistant Chief of Pathological Division, Bureau of Animal Industry. Pp. 44, pls. 4. Bulletin No. 45. September 10, 1903. Price, 10 cents 2,500

Reprint, December 9, 1903 1,000

Sheep Ranching in the Western States. By E. V. Wilcox, of the Office of Experiment Stations. Pp. ii, 79–98, pls. 12. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) September 24, 1903 1,000

Report on an Enzootic Among Cattle Caused by a Bacillus of the Enteritidis Group. By John R. Mohler, A. M., V. M. D., Chief of Pathological Division, Bureau of Animal Industry, and John S. Buckley, D. V. S., Assistant in Pathological Laboratory, Bureau of Animal Industry. Pp. ii, 297–331, pls. 5. (Reprint from Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) September 24, 1903 200

Index-Catalogue of Medical and Veterinary Zoology. Part 5. [Authors: E to Eyssel.] By Ch. Wardell Stiles, Ph. D., Consulting Zoologist of Bureau of Animal Industry, Zoologist of U. S. Public Health and Marine-Hospital Service, and Albert Hassall, M. R. C. V. S., Veterinary Inspector, Bureau of Animal Industry. Pp. ii, 405–435. Bulletin No. 39. September 25, 1903. Price, 5 cents 2,000

The Animal Industry of Argentina. By Frank W. Bicknell, Special Agent and Agricultural Explorer. Pp. 72, frontispiece, pls. 15. Bulletin No. 48. September 26, 1903. Price, 20 cents 14,000

A Form of Hog Cholera Not Caused by the Hog-Cholera Bacillus. By E. A. de Schweinitz, Chief of Biochemic Division, and M. Dorset, Assistant Chief of Biochemic Division. Pp. 4. Circular No. 41. October 2, 1903 10,000

German Meat Regulations. With Original Text. Pp. 51. Bulletin No. 50. October 14, 1903. Price, 5 cents 2,000

Directions for the Use of Blackleg Vaccine. By Victor A. Norgaard, Chief of Pathological Division, Bureau of Animal Industry. Pp. 8, figs. 3. Circular No. 23, second revision. (Reprint.) November 7, 1903 10,000

Reprint, February 26, 1904 10,000

Information Concerning Common Goats. By George Fayette Thompson, Editor of Bureau. Pp. 14. Circular No. 42. November 10, 1903 8,000

Copies.

Market Milk: A Plan for Its Improvement. By R. A. Pearson, M. S., Assistant Chief of Dairy Division. Pp. iii, 158–193, pls. 10. (Reprint from the Seventeenth Annual Report of the Bureau of Animal Industry, 1900.) November 18, 1903 3,000

Report of the Chief of the Bureau of Animal Industry for 1903. By D. E. Salmon. Pp. ii, 47–83. December 12, 1903 500

The Available Energy of Timothy Hay. Investigations with the Respiration Calorimeter, in Cooperation with the Pennsylvania State College Agricultural Experiment Station. By Henry Prentiss Armsby, Ph. D., and J. August Fries, B. S. Pp. 77, pls. 2, diags. 4. Bulletin No. 51. January 11, 1904. Price, 10 cents 2,500

American Breeds of Fowls. I.—The Plymouth Rock. By T. F. McGrew. Pp. 32, pls. 6, figs. 10. Bulletin No. 29. (Reprint.) January 16, 1904. Price, 15 cents 1,000

American Breeds of Fowls. II.—The Wyandotte. By T. F. McGrew. Pp. 30, pls. 10, figs. 3. Bulletin No. 31. (Reprint.) January 16, 1904. Price, 15 cents 1,000

Reports on Bovine Tuberculosis and Public Health. By D. E. Salmon, D. V. M., Chairman of the Committee on Animal Diseases and Animal Food of the American Public Health Association. Pp. 63. Bulletin No. 53. January 19, 1904. Price, 5 cents 5,000

Index-Catalogue of Medical and Veterinary Zoology. Part 6. [Authors: F to Fynney.] By Ch. Wardell Stiles, Ph. D., Consulting Zoologist of Bureau of Animal Industry, Zoologist of U. S. Public Health and Marine-Hospital Service, and Albert Hassall, M. R. C. V. S., Veterinary Inspector, Bureau of Animal Industry. Pp. 437–510. Bulletin No. 39. February 11, 1904. Price, 5 cents 2,000

Blackleg: Its Nature, Cause, and Prevention. By Victor A. Nörgaard, Chief of Pathological Division. Pp. 22, fig. 1. Circular No. 31, revised. (Reprint.) February 15, 1904 10,000

Experiments Concerning Tuberculosis, Under the Supervision of the Biochemic Division. Part I. The Virulence of Human and Bovine Tubercle Bacilli for Guinea Pigs and Rabbits. By Marion Dorset, M. D., Assistant Chief of Biochemic Division, Bureau of Animal Industry. Pp. 30, pls. 5. Bulletin No. 52. Part I. February 17, 1904. Price, 10 cents 2,436

Immunization from Hog Cholera. Pp. 3. Circular No. 43. February 23, 1904 2,000
Reprint, April 11, 1904 1,000

The Hog Industry. Selection, Feeding, and Management. Recent American Experimental Work. Statistics of Production and Trade. By George M. Rommel, B. S. A., Expert in Animal Husbandry, Bureau of Animal Industry. Pp. 96. Bulletin No. 47. Part I. February 23, 1904. Price, 10 cents 6,000
Part II. Pp. 97–192. February 24, 1904. Price, 10 cents 6,000
Part III. Pp. 193–298, maps 3. February 24, 1904. Price, 10 cents 6,000
Reprint, May 26, 1904. Price, 30 cents 6,000

Laws (Federal, State, and Territorial) Relating to Contagious and Infectious Diseases of Animals. 1902 and 1903. Pp. 46. Bulletin No. 54. Price, 5 cents 1,500

Statistics of the Dairy. Compiled from the United States Census for 1900 and from Other Reliable Sources, with Explanatory Notes, by Henry E. Alvord, C. E., Chief of the Dairy Division. Pp. 88, pls. 9. Bulletin No. 55. February 27, 1904. Price, 10 cents 10,000

Studies Upon the Keeping Quality of Butter. I.—Canned Butter. By Lore A. Rogers, Expert in Dairy Bacteriology, Bureau of Animal Industry. Pp. 24. Bulletin No. 57. March 1, 1904. Price, 5 cents 5,500

Officials, Associations, and Educational Institutions connected with the Dairy Interests of the United States for the Year 1904. By Henry E. Alvord, Chief of Dairy Division. Pp. 12. Circular No. 44. April 9, 1904 5,000

The Fat Testing of Cream by the Babcock Method. By Ed. H. Webster, Inspector and Dairy Expert, Dairy Division, Bureau of Animal Industry. Pp. 29, pls. 2, fig. 1. Bulletin No. 58. May 6, 1904. Price, 5 cents 10,000

Copies.

Digestion Experiments with Poultry. By E. W. Brown, Ph. D., Assistant in the Biochemic Division. Prepared Under the Supervision of E. A. de Schweinitz, Ph. D., Chief of Biochemic Division of the Bureau of Animal Industry. Pp. 112, pls. 4, charts 2. Bulletin No. 56. May 21, 1904. Price, 20 cents 1,000

Relations of Federal Government to Control of Contagious Diseases of Animals. By D. E. Salmon, D. V. M., Chief of the Bureau of Animal Industry. Pp. ii, 491–506. (From Yearbook of Department of Agriculture for 1903.) June 7, 1904 500

Milk Fever: Its Simple and Successful Treatment. By John R. Mohler, V. M. D., Chief of Pathological Division. Pp. 13. Circular No. 45. June 11, 1904 7,000

The International Dairy Federation and International Dairy Congresses. By Henry E. Alvord, Chief of Dairy Division. Pp. 14. Circular No. 46. June 18, 1904 2,000

The Farm Separator: Its Relation to the Creamery and to the Creamery Patron. By Ed. H. Webster, Inspector and Dairy Expert, Dairy Division Bureau of Animal Industry. Pp. 47. Bulletin No. 59. June 24, 1904. Price, 5 cents 10,000

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Soil Survey of the Billings Area, Montana. By Charles A. Jensen and N. P. Neill. Pp. 665–687, maps 3, pl. 1, fig. 1. (Reprint from Field Operations, Bureau of Soils, 1902.) November 3, 1903 ---------- 1,000

Soil Survey of the Lyons Area, New York. By Edward Hearn. Pp. 143–162, map. (Reprint from Field Operations, Bureau of Soils, 1902.) November 18, 1903 ---------- 1,000

Soil Survey of the Lewiston Area, Idaho. By Louis Mesmer. Pp. 689–709, map, fig. 1. (Reprint from Field Operations, Bureau of Soils, 1902.) November 18, 1903 ---------- 1,000

Soil Survey of Howell County, Missouri. By Elmer O. Fippin and James L. Burgess. Pp. 593–609, map, fig. 1. (Reprint from Field Operations, Bureau of Soils, 1902.) November 19, 1903 ---------- 1,000

Soil Survey of the Stuttgart Area, Arkansas. By J. E. Lapham. Pp. 611–622, map, fig. 1. (Reprint from Field Operations, Bureau of Soils, 1902.) November 19, 1903 ---------- 1,000

Soil Survey of Perry County, Alabama. By R. T. Avon Burke and party. Pp. 309–323, map. (Reprint from Field Operations, Bureau of Soils, 1902.) November 25, 1903 ---------- 1,000

Soil Survey of the Mount Mitchell Area, North Carolina. By Thomas A. Caine and A. W. Mangum. Pp. 259–271, map. (Reprint from Field Operations, Bureau of Soils, 1902.) November 25, 1903 ---------- 1,000

Reprint, March 4, 1904 ---------- 1,000

Soil Survey of the Smedes Area, Mississippi. By William G. Smith and William T. Carter, jr. Pp. 325–348, maps 2, fig. 1. (Reprint from Field Operations, Bureau of Soils, 1902.) November 25, 1903 ---------- 1,000

Soil Survey of the Walla Walla Area, Washington. By J. Garnett Holmes. Pp. 711–728, map, fig. 1. (Reprint from Field Operations, Bureau of Soils, 1902.) November 25, 1903 ---------- 1,000

Soil Survey of the Albemarle Area, Virginia. By Charles N. Mooney and F. E. Bonsteel. Pp. 187–238, fig. 1, maps 3. (Reprint from Field Operations, Bureau of Soils, 1902.) November 25, 1903 ---------- 1,000

Soil Survey of the Brazoria Area, Texas. By Frank Bennett, jr., and Grove B. Jones. Pp. 349–364, fig. 1, map 1. (Reprint from Field Operations, Bureau of Soils, 1902.) December 2, 1903 ---------- 1,000

Soil Survey of the Hickory Area, North Carolina. By Thomas A. Caine. Pp. 239–258, fig. 1, maps 2. (Reprint from Field Operations, Bureau of Soils, 1902.) December 3, 1903 ---------- 1,000

Reprint, March 4, 1904 ---------- 1,000

Copies.

Soil Survey from Arecibo to Ponce, Porto Rico. By Clarence W. Dorsey, Louis Mesmer, and Thomas A. Caine. Pp. 793–839, fig. 1, map 1. (Reprint from Field Operations, Bureau of Soils, 1902.) December 3, 1903 ---- 1,000

Soil Survey of the Wichita Area, Kansas. By J. E. Lapham and B. A. Olshausen. Pp. 623–624, fig. 1, map 1. (Reprint from Field Operations, Bureau of Soils, 1902.) December 5, 1903 ---- 1,000

Soil Survey of the Yuma Area, Arizona. By Garnett Holmes. Pp. 777–791, fig. 1, map 1. (Reprint from Field Operations, Bureau of Soils, 1902.) December 5, 1903 ---- 1,000

Report of the Chief of the Bureau of Soils for 1903. By Milton Whitney. Pp. iii, 199–226. (From Annual Reports, Department of Agriculture.) December 14, 1903 ---- 200

Reclamation of Alkali Land near Salt Lake City, Utah. By W. H. Heileman. Pp. 8, fig. 1. Circular No. 12. February 20, 1904 ---- 8,000

The Work of the Bureau of Soils. Pp. 13. Circular No. 13. April 5, 1904 ---- 15,000

Some Results of Investigations in Soil Management. By F. H. King, Chief of Division of Soil Management, Bureau of Soils. Pp. iii, 159–174. (From Yearbook of Department of Agriculture for 1903.) June 7, 1904 ---- 300

The Culture of Tobacco. By Otto Carl Butterweck. Pp. 24. Farmers' Bulletin No. 82. (Reprint.) January 18, 1904 ---- 15,000

Tobacco Soils. By Milton Whitney, Chief of Division of Soils. Pp. 24, fig. 1. Farmers' Bulletin No. 83. (Reprint.) May 28, 1904 ---- 10,000

BUREAU OF STATISTICS.

Crop Reporter. Vol. 5, No. 3. July, 1903 ---- 100,000

Crop Reporter. Vol. 5, No. 4. August, 1903 ---- 100,000

Crop Reporter. Vol. 5, No. 5. September, 1903. Pp. 33–40 ---- 110,000

Crop Reporter. Vol. 5, No. 6. October, 1903. Pp. 41–48 ---- 105,000

Crop Reporter. Vol. 5, No. 7. November, 1903. Pp. 49–56 ---- 100,000

Crop Reporter. Vol. 5, No. 7. November, 1903. Pp. 49–56. (Reprint.) ---- 100,000

Crop Reporter. Vol. 1, No. 10. February, 1900. Pp. 4. (Reprint.) ---- 500

Crop Reporter. Vol. 1, No. 11. March, 1900. Pp. 4. (Reprint.) ---- 500

Crop Reporter. Vol. 5, No. 8. December, 1903. Pp. 57–60 ---- 100,000

Crop Reporter. Vol. 5, No. 8. Supplement. December, 1903. Pp. 61–68 ---- 100,000

Crop Reporter. Vol. 5, No. 9. January, 1904. Pp. 69–76 ---- 100,000

Crop Reporter. Vol. 5, No. 10. February, 1904. Pp. 77–84 ---- 100,000

Crop Reporter. Vol. 2, No. 3. July, 1900. Pp. 8. (Reprint.) ---- 500

Crop Reporter. Vol. 5, No. 11. March, 1904. Pp. 85–92 ---- 100,000

Crop Reporter. Vol. 5, No. 12. April, 1904. Pp. 93–100 ---- 100,000

Crop Reporter. Vol. 6, No. 1. May, 1904. Pp. 1–8 ---- 100,000

Crop Reporter. Vol. 6, No. 2. June, 1904. Pp. 9–16 ---- 100,000

Milk Transportation: Freight Rates to the Largest Fifteen Cities in the United States. By Edward G. Ward, jr., Expert in Transportation Statistics. Pp. 60. Bulletin No. 25. July 25, 1903. Price, 5 cents ---- 10,000

Report of the Acting Statistician for 1903. By Edwin Holmes, jr. Pp. iii, 439–445. (From Annual Reports, Department of Agriculture.) December 11, 1903 ---- 500

Wages of Farm Labor in the United States. Results of Twelve Statistical Investigations, 1866–1902. By James H. Blodgett, A. M. Pp. 62. Miscellaneous series. Bulletin No. 26. December 28, 1903. Price, 5 cents ---- 15,000

Reprint, January 16, 1904 ---- 10,000

Foreign Trade in Farm and Forest Products, 1903. By George K. Holmes, Chief of Division of Foreign Markets. Pp. 20. Circular No. 15. January 25, 1904 ---- 4,500

The Future Demand for American Cotton. By J. L. Watkins, Cotton Expert, Division of Statistics. Pp. ii, 193–206. (From Yearbook of the Department of Agriculture for 1901.) March 24, 1904. (Reprint.) ---- 1,000

	Copies.
The Industry in Oil Seeds. By Charles M. Daugherty, of the Bureau of Statistics. Pp. iii, 411–426. (From Yearbook of Department of Agriculture for 1903.) June 9, 1904	3,000
The Nation's Farm Surplus. By George K. Holmes, Chief of the Division of Foreign Markets, Bureau of Statistics. Pp. iii, 479–490. (Reprint from Yearbook of Department of Agriculture for 1903.) June 9, 1904	5,000
Statistical Matter Relating to Principal Crops and Farm Animals, Freight Rates, Exports, etc., of the United States, 1903. Pp. 584–700 (From Yearbook of Department of Agriculture for 1903.) June 18, 1904	10,000
Consumption of Cotton in the Cotton States. By J. L. Watkins, Cotton Expert, Bureau of Statistics. Pp. iii, 463–478, pls. 5, fig. 1. (From Yearbook of Department of Agriculture for 1903.) June 20, 1904	6,000
Wheat Production and Farm Life in Argentina. By Frank W. Bicknell, Special Agent and Agricultural Explorer. Pp. 100, pls. 10. Bulletin No. 27. Price, 10 cents	10,000

Division of Foreign Markets.

Distribution of the Agricultural Exports of the United States, 1898–1902. By Frank H. Hitchcock. Pp. 224. Bulletin No. 32. July 3, 1903. Price, 15 cents	6,000
Sources of the Agricultural Imports of the United States, 1898–1902. By Frank H. Hitchcock. Pp. 150. Bulletin No. 31. July 28, 1903. Price, 10 cents	6,000
Belgium's Foreign Trade in Agricultural Products for 1902. By Frank H. Hitchcock, Chief. Pp. 8. Circular No. 26. August 1, 1903	9,000
Foreign Trade of the United States in Forest Products, 1902. By Frank H. Hitchcock. Pp. 70. Bulletin No. 33. August 15, 1903. Price, 5 cents	6,000
Agricultural Imports of Germany, 1897–1901. By Frank H. Hitchcock. Pp. 323. Bulletin No. 30. November 25, 1903. Price, 20 cents	1,000
Report of Chief of the Division of Foreign Markets for 1903. By George K. Holmes. Pp. iii, 447–453. (From Annual Reports, Department of Agriculture.) December 28, 1903	200
Foreign Import Tariffs on Fruits and Nuts, 1903. By Frank H. Hitchcock. Pp. 69. Bulletin No. 36. March 26, 1904. Price, 5 cents	6,000
Foreign Import Tariffs on Meat Products, 1903. By Frank H. Hitchcock. Pp. 64. Bulletin No. 35. April 8, 1904. Price, 5 cents	6,000
Foreign Import Tariffs on Grain and Grain Products, 1903. By Frank H. Hitchcock. Pp. 59. Bulletin No. 37. April 11, 1904. Price, 5 cents	6,000

WEATHER BUREAU.

Monthly Weather Review (a summary by months of weather conditions throughout the United States, based upon reports of nearly 3,000 regular and voluntary observers). Quarto. Price, 20 cents; $2 per year.	
Vol. XXXI, No. 5. May, 1903. Pp. 217–258, charts 22, figs. 2	4,800
Vol. XXXI, No. 6. June, 1903. Pp. 259–307, figs. 7, charts 9	4,800
Vol. XXXI, No. 7. July, 1903. Pp. 309–363, figs. 18, charts 9	4,800
Vol. XXXI, No. 8. August, 1903. Pp. 365–406, figs. 8, charts 10	4,800
Vol. XXXI, No. 9. September, 1903. Pp. 407–448, charts 10	4,800
Vol. XXXI, No. 10. October, 1903. Pp. 449–502, figs. 6, charts 10	4,800
Vol. XXXI, No. 11. November, 1903. Pp. 503–563, figs. 16, charts 12	4,800
Vol. XXXI, No. 12. December, 1903. Pp. 565–624, figs. 9, charts 12	4,800
Vol. XXXI, No. 13. Pp. vii, 625–652, charts 8	4,800
Vol. XXXII, No. 1. January, 1904. Pp. 50, charts 12	4,800
Vol. XXXII, No. 2. February, 1904. Pp. 51–104, figs. 18, charts 12	4,800
Vol. XXXII, No. 3. March, 1904. Pp. 105–158, figs. 7, charts 10	4,800
Vol. XXXII, No. 4. April, 1904. Pp. 159–206, charts 20	4,800
Climate and Crop Bulletin No. 16. July 6, 1903	4,575
Climate and Crop Bulletin No. 17. July 13, 1903	4,575
Climate and Crop Bulletin No. 18. July 20, 1903	4,600
Climate and Crop Bulletin No. 19. July 27, 1903	4,600

		Copies.
Climate and Crop Bulletin No. 20.	August 3, 1903	4, 600
Climate and Crop Bulletin No. 21.	August 10, 1903	4, 600
Climate and Crop Bulletin No. 22.	August 17, 1903	4, 600
Climate and Crop Bulletin No. 23.	August 24, 1903	4, 600
Climate and Crop Bulletin No. 24.	August 31, 1903	4, 600
Climate and Crop Bulletin No. 25.	September 7, 1903	4, 600
Climate and Crop Bulletin No. 26.	September 15, 1903	4, 600
Climate and Crop Bulletin No. 27.	September 21, 1903	4, 600
Climate and Crop Bulletin No. 28.	September 28, 1903	4, 600
Climate and Crop Bulletin No. 29.	October 5, 1903	4, 600
Climate and Crop Bulletin No. 30.	October, 1903	4, 650
Climate and Crop Bulletin No. 31.	November, 1903	4, 800
Climate and Crop Bulletin No. 32.	December, 1903	4, 950
Climate and Crop Bulletin No. 1.	January, 1904	4, 950
Climate and Crop Bulletin No. 2.	February, 1904	4, 950
Climate and Crop Bulletin No. 3.	March, 1904	5, 050
Climate and Crop Bulletin No. 4.	April 11, 1904	4, 650
Climate and Crop Bulletin No. 5.	April 18, 1904	4, 700
Climate and Crop Bulletin No. 6.	April 25, 1904	4, 800
Climate and Crop Bulletin No. 7.	May 2, 1904	4, 700
Climate and Crop Bulletin No. 8.	May 9, 1904	4, 700
Climate and Crop Bulletin No. 9.	May 16, 1904	4, 500
Climate and Crop Bulletin No. 10.	May 23, 1904	4, 700
Climate and Crop Bulletin No. 11.	May 30, 1904	4, 700
Climate and Crop Bulletin No. 12.	June 7, 1904	4, 500
Climate and Crop Bulletin No. 13.	June 14, 1904	4, 500
Climate and Crop Bulletin No. 14.	June 26, 1904	4, 500
Climate and Crop Bulletin No. 15.	June 28, 1904	4, 500
Snow and Ice Bulletin.	December 8, 1903	1, 850
Snow and Ice Bulletin.	December 22, 1903	1, 850
Snow and Ice Bulletin.	December 29, 1903	1, 850
Snow and Ice Bulletin.	January 5, 1904	1, 850
Snow and Ice Bulletin.	January 12, 1904	1, 850
Snow and Ice Bulletin.	January 19, 1904	1, 850
Snow and Ice Bulletin.	January 26, 1904	1, 850
Snow and Ice Bulletin.	February 2, 1904	1, 850
Snow and Ice Bulletin.	February 9, 1904	1, 950
Snow and Ice Bulletin.	February 23, 1904	1, 950
Snow and Ice Bulletin.	March 1, 1904	1, 850
Snow and Ice Bulletin.	March 8, 1904	1, 850
Snow and Ice Bulletin.	March 15, 1904	1, 875
Snow and Ice Bulletin.	March 22, 1904	1, 875
Snow and Ice Bulletin.	March 29, 1904	1, 875

Storms of the Great Lakes. By E. B. Garriott, Professor of Meteorology. Pp. 9, charts 568. Bulletin K. (W. B. No. 288.) Quarto. Cloth. July 25, 1903. Price, 50 cents — 2, 000

Studies in the Meteorological Effects in the United States of the Solar and Terrestrial Physical Processes. Reprints from the Monthly Weather Review, December, 1902, January and February, 1903. By Frank H. Bigelow, M. A., L. H. D., Professor of Meteorology. (W. B. No. 290.) August 7, 1903 — 500

Climatology of California. By Alexander G. McAdie, Professor of Meteorology. Pp. 270, frontispiece, pls. 12, figs. 31. Bulletin L. (W. B. No. 292.) November 23, 1903. Price, 50 cents — 3, 500

Weather Folk-Lore and Local Weather Signs. By Edward B. Garriott, Professor of Meteorology. Pp. 153, charts 21. Bulletin No. 33. (W. B. No. 294.) November 23. Price, 25 cents — 5, 000

Same bound in cloth. February 6. Price, 35 cents — 3, 500

Report of the Chief of the Weather Bureau for 1903. By Willis L. Moore. Pp. iii, 3–46. December 12, 1903 — 5, 000

Meteorological Chart of the Great Lakes. Summary for the Season of 1903. No. 2, 1903. By Alfred J. Henry and Norman B. Conger. Pp. 17, chart 1. March 17, 1904. Price, 10 cents — 2, 500

The Floods of the Spring of 1903, in the Mississippi Watershed. By H. C. Frankenfield, District Forecaster, in Charge of River and Flood Service. Pp. 63, pls. 16, figs. 3, charts 15. Bulletin M. (W. B. No. 303.) May 10, 1904. Price, $1 — 3, 500

	Copies.
Relation of Precipitation to Yield of Corn. By J. Warren Smith, Section Director, Weather Bureau. Pp. ii, 215–224, figs. 8. June 7, 1904	300
Use of Weather Bureau Records in Court. By Henry J. Cox, Professor of Meteorology, Weather Bureau. Pp. ii, 303–312. June 7, 1904	300
Weather Bureau Stations and Their Duties. By James Kenealy, Local Forecaster, Weather Bureau. Pp. iii, 109–120, figs. 2. June 7, 1904	500
Protection of Food Products from Injurious Temperatures. By H. E. Williams, Chief Clerk, Weather Bureau. Pp. 28. Farmers' Bulletin No. 125. (Reprint.) March 5, 1904	15,000

APPENDIX B.

REPORT IN DETAIL OF PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RECEIVED AND DISTRIBUTED DURING THE FISCAL YEAR ENDED JUNE 30, 1904, THE PUBLICATION OF WHICH IS PROVIDED FOR BY LAW.

[NOTE.—The publications of the Weather Bureau are not distributed from the Division of Publications, but by an official in that Bureau specially charged with such work, and directed by the order of the Secretary of Agriculture, dated March 29, 1897, to report to the chief of this Division. A list of Weather Bureau publications is given in separate tables.]

Publications other than Farmers' Bulletins received and distributed from July 1, 1903, to June 30, 1904.

Publications.	Received.	Distributed.
Publications on hand July 1, 1903	[a] 746,761	[a] 637,625
OFFICE OF APPOINTMENT CLERK.		
Report of the Appointment Clerk, 1903	1,000	575
DIVISION OF ACCOUNTS AND DISBURSEMENTS.		
Report of Chief of Accounts and Disbursements, 1903	200	164
BUREAU OF ANIMAL INDUSTRY.		
Report of Chief, 1903	500	500
Bulletin No. 29	1,000	747
Bulletin No. 31	1,000	826
Bulletin No. 39, Part IV	2,000	1,412
Bulletin No. 39, Part V	2,000	1,380
Bulletin No. 39, Part VI	2,000	1,386
Bulletin No. 45	3,500	2,961
Bulletin No. 46	11,000	10,750
Bulletin No. 47	8,000	7,235
Bulletin No. 48	14,000	9,225
Bulletin No. 49	10,000	7,613
Bulletin No. 50	2,000	1,724
Bulletin No. 51	2,500	2,024
Bulletin No. 52, Part I	2,436	2,411
Bulletin No. 53	5,000	3,200
Bulletin No. 54	1,500	1,500
Bulletin No. 55	10,000	6,572
Bulletin No. 56	1,000	1,000
Bulletin No. 57	5,500	3,922
Bulletin No. 58	10,000	10,000
Bulletin No. 59	10,000	8,952
Nineteenth Annual Report Bureau of Animal Industry	9,000	6,500
Market Milk, etc. (Reprint from Seventeenth Annual Report Bureau of Animal Industry)	3,000	1,351
Reprints from Nineteenth Annual Report Bureau of Animal Industry:		
The Duration of the Life of the Tubercle Bacillus in Cheese	5,000	3,876
Feeding Fat into Milk, etc	8,000	7,320
Distribution and Magnitude of the Poultry and Egg Industry	2,500	1,619
Sheep Ranching in the Western States	1,000	610
Report on Enzootic Among Cattle, etc	200	162
The Tuberculin Test of Cattle in Great Britain	500	500
Statistics of Oleomargarine, Oleo Oil, and Filled Cheese	1,000	925
The American Saddle Horse	2,000	1,900
Foot-and-Mouth Disease	6,000	4,150

[a] Miscellaneous publications printed prior to July 1, 1903.

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
BUREAU OF ANIMAL INDUSTRY—continued.		
Special Report on the Diseases of the Horse	8,000	2,137
Bureau of Animal Industry circulars:		
No. 23	20,000	16,644
No. 31	10,000	5,000
No. 41	10,000	6,000
No. 42	8,000	4,800
No. 43	3,000	3,000
No. 44	5,000	4,000
No. 45	7,000	3,490
No. 46	2,000	932
BIOLOGICAL SURVEY.		
Report of Chief, 1903	800	475
Bulletin No. 17	1,000	1,000
Circular No. 17	3,000	a 3,512
Circular No. 29	1,000	360
Circular No. 39	3,000	2,800
Circular No. 40	1,200	1,175
Circular No. 41	1,000	1,000
Circular No. 42	2,500	2,500
North American Fauna No. 22	1,000	600
North American Fauna No. 23	1,000	871
CHEMISTRY.		
Report of Chemist, 1903	500	453
Bulletin No. 13, part 9	1,000	907
Bulletin No. 13, part 10	1,000	852
Bulletin No. 46	1,500	945
Bulletin No. 69, part 6	3,500	1,808
Bulletin No. 71	1,500	1,462
Bulletin No. 73	500	497
Bulletin No. 76	2,000	1,501
Bulletin No. 77	3,000	2,661
Bulletin No. 78	2,000	1,433
Bulletin No. 79	4,000	4,000
Bulletin No. 80	4,500	3,730
Bulletin No. 81	1,000	1,000
Determination of Gliadin in Flour, etc. (Reprint Bul. 81)	100	100
Bulletin No. 82	3,000	1,634
Bulletin No. 83, part 1	1,000	1,000
Circular No. 8	150	375
Circular No. 13	2,250	1,560
ENTOMOLOGY.		
Report of Entomologist, 1903	500	330
Bulletin No. 40	1,000	1,017
Bulletin No. 41	3,500	2,050
Bulletin No. 42	2,000	1,974
Bulletin No. 43	2,750	2,200
Bulletin No. 44	3,500	2,827
Bulletin No. 45	1,000	1,000
Bulletin No. 46	3,500	3,012
Bulletin No. 47	1,000	1,000
Bulletin No. 48	5,000	1,174
Bulletin No. 25, old series (reprint)	2,000	1,010
Circular No. 7	3,000	140
Circular No. 18	2,000	1,000
Circular No. 28	2,000	450
Circular No. 37	2,500	1,020
Circular No. 38	2,500	500
Circular No. 48	2,000	600
Circular No. 52	3,000	2,600
Circular No. 53	2,500	1,200
Circular No. 54	3,500	2,200
Circular No. 55	3,500	1,800
Insect Photography (reprint Entomology Bul. 46)	300	100
Notes on New Facts about Some New York Grape Pests (reprint Entomology Bul. 46)	100	100
Some Serious Insect Depredations in New York (reprint Entomology Bul. 46)	100	100
On Some of the Aphides Affecting Grain, etc. (reprint from Bulletin No. 44, Entomology)	100	100
The Chestnut Weevils (reprint from Bul. No. 44)	1,000	400

a Where the number distributed is greater than the number received, the difference is accounted for by the number on hand at the beginning of the year.

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
FORESTRY.		
Report of the Forester, 1903	15,000	13,142
Bulletin No. 7	1,000	664
Bulletin No. 17	2,500	1,375
Bulletin No. 24	10,000	3,580
Bulletin No. 26	2,500	555
Bulletin No. 31	1,000	885
Bulletin No. 37	5,000	1,206
Bulletin No. 40	4,000	1,893
Bulletin No. 41	6,600	5,596
Bulletin No. 42	10,000	11,155
Bulletin No. 43	10,000	5,700
Bulletin No. 44	6,000	5,800
Bulletin No. 45	10,000	5,840
Bulletin No. 50	10,000	9,400
Circular No. 12	2,000	1,000
Circular No. 21	5,000	4,400
Circular No. 22	6,000	5,000
Circular No. 23	2,000	2,395
Circular No. 25	5,000	6,236
Circular No. 26	25,000	15,680
Circular No. 27	7,000	6,350
Circular No. 28	15,000	5,076
Press Bulletin No. 40	5,500	5,500
Press Bulletin No. 41	5,500	5,500
Press Bulletin No. 42	5,500	5,500
Press Bulletin No. 43	5,500	5,500
Press Bulletin No. 44	5,500	5,500
Press Bulletin No. 45	5,500	5,500
Press Bulletin No. 46	5,500	5,500
Press Bulletin No. 47	5,500	5,500
Press Bulletin No. 48	5,500	5,500
FOREIGN MARKETS.		
Report of Chief, 1903	200	150
Bulletin No. 30	1,000	1,000
Bulletin No. 31	6,000	1,200
Bulletin No. 32	6,000	4,020
Bulletin No. 33	6,000	4,870
Bulletin No. 35	6,000	4,564
Bulletin No. 36	6,000	4,521
Bulletin No. 37	6,000	4,531
Circular No. 26	9,000	8,300
OFFICE OF EXPERIMENT STATIONS.		
Report of Director, 1903	3,000	2,460
Bulletin No. 28	2,000	2,813
Bulletin No. 44	500	196
Bulletin No. 67	500	250
Bulletin No. 68	500	247
Bulletin No. 121	500	279
Bulletin No. 127	5,000	2,150
Bulletin No. 129	3,500	2,687
Bulletin No. 130	2,500	1,685
Bulletin No. 131	2,500	1,625
Bulletin No. 132	3,500	3,251
Bulletin No. 133	1,000	1,000
Report of Irrigation Investigation for 1902:		
No. I	1,000	510
No. II	1,000	466
No. III	1,000	776
Bulletin No. 134	2,500	1,370
Bulletin No. 135	2,000	1,290
Bulletin No. 136	1,000	958
Bulletin No. 137	3,500	2,902
Bulletin No. 138	1,000	1,000
Proceedings of Eighth Annual Meeting American Association of Farmers' Institute Workers:		
Minutes of Meeting, Part I (reprint from O. E. S. Bul. 138)	4,000	212
Papers of Discussion, Part II (reprint from O. E. S. Bul. 138)	4,000	300
Constitution and by-laws of the American Association of Farmers' Institute Workers, etc. (reprint from O. E. S. Bul. 138)	200	200
Bulletin No. 139	5,000	3,070
Bulletin No. 140	2,500	1,207
Bulletin No. 141	4,000	3,202
Bulletin No. 142	1,000	820
Bulletin No. 143	3,500	441
Record, Vol. 15, No. 1	6,000	5,869
New Agricultural Building at the University of Wisconsin (reprint from Record, Vol. 15, No. 1)	200	200
Record, Vol. 15, No. 2	5,000	4,650

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
OFFICE OF EXPERIMENT STATIONS—continued.		
Record, Vol. 15, No. 3	6,000	5,700
The New Building of Farm Mechanics at Iowa College of Agriculture and Mechanic Arts (reprint from Record, Vol. 15, No. 3)	500	404
Record, Vol. 15, No. 4	6,000	5,710
Record, Vol. 15, No. 5	6,000	5,600
Record, Vol. 15, No. 6	6,000	5,610
Record, Vol. 15, No. 7	6,000	5,500
New Dairy Barn at the Kentucky Experiment Station (reprint, Record, Vol. 15, No. 7)	200	200
Record, Vol. 15, No. 8	6,000	5,505
A Respiration Calorimeter for Farm Animals (reprint from Record, Vol. 15, No. 8)	200	200
Rural Economics as a Subject of Under-Graduate Study (reprint from Record, Vol. 15, No. 8)	200	200
Record, Vol. 15, No. 9	6,000	5,600
Record, Vol. 15, No. 10	6,000	1,000
Porto Rico Bulletin No. 3	1,000	1,000
Porto Rico Bulletin No. 3 (Spanish edition)	2,000	1,795
Circular No. 46	1,000	1,000
Circular No. 51	500	500
Circular No. 52	11,500	11,468
Circular No. 53	3,500	2,622
Circular No. 54	500	471
Circular No. 55	5,000	1,910
Circular No. 56	500	500
Circular No. 57	1,000	822
Circular No. 58	500	500
Annual Report of the Office of Experiment Stations for the Year ended June 30, 1903	5,000	400
Reprints from Annual Report, Office of Experiment Stations, 1903:		
Development of the Text-Book of Agriculture in North America	500	325
Nutrition Investigations at the Government Hospital for the Insane	200	200
Organization of Governing Boards and Rules Adopted by them for the Regulation of Agricultural Experiment Stations	200	175
A Summary of Recent American Work on Feeding Stuffs	500	200
Experiment Station Work with Apples	500	75
Statistics of Land-Grant Colleges, etc	500	300
Federal Legislation, Regulations, etc	500	190
Annual Report of the Hawaii Agricultural Experiment Station	1,000	75
Farmers' Institutes in the United States	2,000	1,455
Annual Report of the Alaska Agricultural Experiment Station	2,000	1,575
Report on the Work and Expenditures of Agricultural Experiment Station, Year ended June 30, 1903	2,000	150
Review of Irrigation Investigations, 1903	1,000	105
Annual Report of the Porto Rico Agricultural Experiment Station, 1903	1,000	78
Progress in Agricultural Education, 1903	1,000	165
Instruction in Agriculture in Land-Grant Colleges and Schools for Colored Persons	500	115
Agricultural Economics as a Subject of Study in the Agricultural College	500	165
Document No. 706—The American System of Agricultural Education	5,000	1,000
Document No. 710—Description of Exhibit of Colleges of Agriculture and Mechanic Arts, etc	5,000	1,000
Reprints from Office Experiment Stations Bulletin No. 142:		
Address of the President of the Association of Agricultural Colleges and Experiment Stations	500	210
Memorial Address on President W. L. Brown	200	25
The Mission of Land-Grant Colleges	300	160
The Difference between Four Northern and Four Southern Soils	300	10
The Present Status of Soil Investigations	200	10
Extension and Practical Application of Soil Surveys	200	10
Chemistry of Soils as Related to Crop Production	200	12
Utility of Soil Surveys in the West	200	10
Artificial Irrigation in Humid and Semiarid Districts	200	10
Methods of Conducting Investigations Relating to the Maintenance or Increase of Soil Fertility	200	10
Experiments in Animal Breeding	200	10
Soil Fertility	200	10
Methods of Investigations Relating to the Breeding of Animals	340	150
Crop Rotation in the Southern States as Influenced by Plant Diseases	200	10
Notes on Cooperative Experiments	200	10
The History of the Tobacco Wilt in Granville County, N. C	260	10
The Foundation of Agricultural Teaching	200	10
Methods of Work and Some Results in Forest Insect Investigations	200	10
Importance of Laboratory and Field Work in Economic Entomology, etc	200	10
Cooperative Work in Economic Entomology	200	10
The New Jersey Ideal in the Study and Report upon Injurious Insects	200	10
The Necessity of Uniform Methods of Inspection and Treatment of Nursery Stock	200	10
Experiment Station Work:		
Vol. II, No. 4	3,000	2,800
Vol. II, No. 5	3,000	80

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
LIBRARY.		
Report of the Librarian, 1903	200	130
Bulletin No. 47	1,000	1,000
Bulletin No. 48	1,000	1,000
Bulletin No. 49	1,000	779
Bulletin No. 50	1,000	885
BUREAU OF PLANT INDUSTRY.		
Report of Chief, 1903	500	500
Bulletin No. 1	1,000	444
Bulletin No. 25	2,500	1,433
Bulletin No. 31	2,000	1,457
Bulletin No. 36	1,000	1,255
Bulletin No. 38	3,500	3,366
Bulletin No. 40	5,000	3,660
Bulletin No. 43	3,000	2,600
Bulletin No. 44	5,500	4,800
Bulletin No. 45	2,500	1,675
Bulletin No. 46	3,000	2,655
Bulletin No. 47	3,500	3,500
Bulletin No. 48	10,000	9,700
Bulletin No. 49	6,000	5,430
Bulletin No. 50	3,000	2,806
Bulletin No. 51, part 1	3,000	1,750
Bulletin No. 51, part 2	10,000	9,810
Bulletin No. 51, part 3	3,500	3,500
Bulletin No. 52	3,500	1,422
Bulletin No. 53	5,000	2,471
Bulletin No. 54	2,500	1,471
Bulletin No. 55	3,500	1,518
Bulletin No. 57	4,500	3,547
Bulletin No. 58	3,000	2,225
Bulletin No. 59	4,500	3,476
Bulletin No. 60	3,000	831
Bulletin No. 64	6,000	4,771
Bulletin No. 65	4,500	2,109
Botany.		
Bulletin No. 16	6,000	6,000
Pomology.		
Bulletin No. 8 (reprint)	3,000	2,700
Circular No. 1 (reprint)	1,000	910
Circular No. 3 (reprint)	1,000	1,000
Nut Culture (reprint)	1,000	495
Vegetable Physiology and Pathology.		
Bulletin No. 5 (reprint)	2,000	396
Bulletin No. 27 (reprint)	500	120
PUBLICATIONS.		
Report of Editor, 1903	1,500	100
Circular No. 1 (revised edition)	3,500	3,360
Monthly List of Publications:		
June, 1903	110,000	110,000
July, 1903	110,000	110,000
August, 1903	110,000	110,000
September, 1903	110,000	110,000
October, 1903	110,000	110,000
November, 1903	112,000	112,000
December, 1903	112,500	112,500
January, 1904	115,000	115,000
February, 1904	138,000	138,000
March, 1904	138,500	138,500
April, 1904	140,000	140,000
May, 1904	140,000	140,000
June, 1904	140,000	140,000
List of Bulletins and Circulars for free distribution, No. 247:		
Ninth edition	10,000	9,760
Tenth edition	10,000	10,000
Eleventh edition	10,000	9,600
Press notices:		
No. 465	350	350
No. 466	1,200	1,200
No. 468	1,200	1,200
No. 470	1,200	1,200
No. 471	1,200	1,200
No. 473	1,200	1,200
No. 474	1,500	1,500

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
PUBLICATIONS—continued.		
Press notices—Continued.		
No. 475	1,200	1,200
No. 480	1,200	1,200
No. 481	600	600
No. 483	1,200	1,200
No. 484	1,400	1,400
No. 486	1,200	1,200
No. 488	1,200	1,200
No. 489	1,200	1,200
No. 491	1,200	1,200
No. 492	1,200	1,200
No. 493	1,200	1,200
No. 494	1,200	1,200
ROAD INQUIRY.		
Report of Director, 1903	3,000	2,210
Bulletin No. 12 (reprint)	5,000	8,081
Bulletin No. 17 (reprint)	5,000	1,184
Bulletin No. 24	1,000	300
Bulletin No. 26	25,000	24,400
Circular No. 21	10,000	2,400
Circular No. 23	10,000	4,200
Circular No. 24	10,000	2,000
Circular No. 37	13,000	13,000
SOILS.		
Report of Chief, 1903	200	200
Bulletin No. 22	9,500	8,226
Circular No. 8	1,000	486
Circular No. 10	8,000	7,709
Circular No. 11	8,000	6,700
Circular No. 12	8,000	6,355
Circular No. 13	15,000	8,113
Report of Field Operations for 1902	8,000	4,400
Soil Survey from Arecibo to Ponce	1,000	1,000
Soil Survey of the Wichita Area, Kansas	1,000	279
Soil Survey of the Yuma Area, Arizona	1,000	400
Soil Survey of the Albemarle Area, Virginia	1,000	590
Soil Survey of the Walla Walla Area, Washington	1,000	315
Soil Survey of the Bigflats Area, New York	1,000	414
Soil Survey of the Vernon Area, Texas	1,000	261
Soil Survey of the Darlington Area, South Carolina	1,000	330
Soil Survey of Clay County, Illinois	1,000	400
Soil Survey of the Columbus Area, Ohio	1,000	310
Soil Survey of the Janesville Area, Wisconsin	1,000	494
Soil Survey of St. Clair County, Illinois	1,000	375
Soil Survey of the Trenton Area, New Jersey	1,000	500
Soil Survey of the Abbeville Area, South Carolina	1,000	291
Soil Survey of Clinton County, Illinois	1,000	857
Soil Survey of the Dubuque Area, Iowa	1,000	494
Soil Survey of Union County, Kentucky	1,000	584
Soil Survey of Posey County, Indiana	1,000	396
Soil Survey of Tazewell County, Illinois	1,000	601
Soil Survey of the Toledo Area, Ohio	1,000	402
Soil Survey of the Grand Forks Area, North Dakota	1,000	438
Soil Survey of the Lower Arkansas Valley, Colorado	1,000	265
Soil Survey of the Billings Area, Montana	1,000	330
Soil Survey of the Mount Mitchell Area, North Carolina	2,000	1,678
Soil Survey of the Hickory Area, North Carolina	2,000	1,798
Soil Survey of the Lyons Area, New York	1,000	980
Soil Survey of the Lewiston Area, Idaho	1,000	762
Soil Survey of Howell County, Missouri	1,000	591
Soil Survey of the Stuttgart Area, Kansas	1,000	738
Soil Survey of the Brazoria Area, Texas	1,000	374
Soil Survey of Perry County, Alabama	1,000	760
Soil Survey of the Smedes Area, Mississippi	1,000	389
STATISTICS.		
Report of Acting Statistician, 1903	500	125
Bulletin No. 25	10,000	6,400
Bulletin No. 26	25,000	22,000
Bulletin No. 27	10,000	3,769
Circular No. 15	4,500	4,200
Crop Reporter:		
Vol. 5, No. 3	104,000	103,800
Vol. 5, No. 4	100,000	99,672
Vol. 5, No. 5	114,000	113,600
Vol. 5, No. 6	105,000	104,500
Vol. 5, No. 7	100,000	99,600

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
STATISTICS—continued.		
Crop Reporter—Continued.		
Vol. 5, No. 8	100,000	99,462
Vol. 5, No. 8 (supplement)	100,000	100,000
Vol. 5, No. 9	102,000	101,700
Vol. 5, No. 10	100,000	99,500
Vol. 5, No. 11	100,000	99,600
Vol. 5, No. 12	100,000	99,410
Vol. 6, No. 1	100,000	99,475
Vol. 6, No. 2	100,000	99,500
Vol. 1, No. 10 (reprint)	500	500
Vol. 1, No. 11 (reprint)	500	500
Vol. 2, No. 3 (reprint)	500	500
OFFICE OF SECRETARY.		
Preliminary Report of Secretary, 1903	5,000	2,160
Annual Report of Department, 1903	3,000	2,480
Yearbook, Department of Agriculture, 1903	30,000	19,032
Special Report No. 74	1,000	1,000
Reprints from Report No. 74:		
Sugar-Beet Pulp as Animal Food	6,000	9,158
Single-Germ Beet Balls, etc	1,000	4,881
Principal Insect Enemies of Sugar Beet	200	200
Report No. 75	10,000	7,600
Report No. 76	50,000	49,800
Report No. 77	3,500	1,796
Report No. 78	30,600	7,292
Progress of Beet-Sugar Industry in United States in 1903	60,000	60,000
Circular No. 10	6,000	3,750
Circular No. 11	50,000	50,000
Extracts.		
No. 37, part 2, Reprint, Meadow Lark and Baltimore Oriole	2,000	1,000
No. 37, part 1, Reprint, Four Common Birds, etc	2,000	1,000
No. 47, Small-Fruit Culture for Market	2,000	1,612
No. 66, The Blue Jay and Its Food	2,000	1,000
No. 133, Birds as Weed Destroyers	1,000	1,000
No. 149, Steel-Track Wagon Roads	5,000	991
No. 194, Food for Nestling Birds	1,000	750
No. 233, Some Problems of the Rural Common Schools	2,000	1,500
No. 234, The Future Demand for American Cotton	1,000	1,467
No. 240, Road Building with Convict Labor in the Southern States	10,000	4,109
No. 245, Government Cooperation in Object-Lesson Road Work	5,000	2,585
No. 261, The San Jose Scale	1,000	127
No. 263, Audubon Societies in Relation to the Farmer	1,000	1,000
No. 268, Some of the Principal Insect Enemies of Coniferous Forests in the United States	1,000	1,000
No. 277, Bacteria and the Nitrogen Problem	6,000	7,000
No. 299, The Principal Insect Enemies in 1902	500	444
No. 300, Agricultural Periodicals in Department Library, 1902	1,000	361
No. 301, Weather Bureau Stations and Their Duties	500	475
No. 302, Relation of Precipitation to Yield of Corn	300	281
No. 303, Relation of Federal Government to Control of Contagious Diseases of Animals	500	202
No. 304, The Nation's Farm Surplus	5,000	2,297
No. 305, Progress of Road Building in the Middle States	19,000	10,600
No. 306, Some Soil Problems for Practical Farmers	1,000	302
No. 307, Use of Weather Bureau Records in Court	300	275
No. 308, Consumption of Cotton in the Cotton States	6,000	3,470
No. 309, The Economic Value of the Bobwhite	5,000	2,807
No. 310, The Cultivation of Corn	5,000	272
No. 311, Some Results of Investigations in Soil Management	300	200
No. 312, The Farmers' Institute	3,000	1,355
No. 313, The United States Department of Agriculture and Silk Culture	1,000	205
No. 314, The Growing of Long-Staple Upland Cotton	5,000	5,000
No. 315, Recent Progress in Timber Preservation	15,000	3,503
No. 316, The Status of the Mexican Cotton Boll Weevil in the United States	250	203
No. 318, Preparing Land for Irrigation	1,000	265
No. 319, The Industry in Oil Seeds	3,000	422
No. 320, The Relation of Sugar Beets to General Farming	1,000	213
No. 321, Principal Commercial Plant Fibers	5,000	1,515
No. 322, Some New Facts About Migration of Birds	2,000	1,166
No. 323, A Model Farm	10,000	6,931
No. 324, Wheat Flour and Bread	3,000	585
No. 325, Cultivation of Drug Plants in the United States	5,000	279
No. 326, Macaroni Wheat	2,000	125
No. 327, Insect Injuries to Hardwood Forest Trees	1,500	203
No. 328, Determination of Effect of Preservatives in Food on Health and Digestion	500	403

Publications other than Farmers' Bulletins received and distributed, etc.—Continued.

Publications.	Received.	Distributed.
OFFICE OF SECRETARY—continued.		
Extracts—Continued.		
No. 329, The Relation of Forests to Stream Flow	15,000	3,327
No. 331, The Adulteration of Drugs	200	194
No. 332, Building Sand-Clay Roads in Southern States	15,000	11,206
No. 333, Directory for Farmers	10,000	75
No. 334, Statistical Matter	10,000	1,564
No. 335, The Principal Injurious Insects of 1903	100	100
Report of Chief of Weather Bureau, 1903	5,000	4,000
	4,540,826	4,713,023

Farmers' Bulletins printed, and Congressional and miscellaneous distribution for the fiscal year 1903–4.

No. of bulletin.	Title of bulletin.	Total number received.	Distributed to Congressmen.[a]	Miscellaneous distribution.[a]
	Number on hand July 1, 1903, 3,491,280.			
16	Leguminous Plants	10,000	11,129	16,727
17	Peach Yellows and Peach Rosette		1,681	254
20	Washed Soils		2,312	339
21	Barnyard Manure	13,487	15,433	10,399
22	The Feeding of Farm Animals	105,000	89,416	28,986
24	Hog Cholera and Swine Plague	70,000	68,097	12,841
25	Peanuts: Culture and Uses		12,025	9,077
27	Flax for Seed and Fiber		5,556	3,397
28	Weeds: And How to Kill Them	50,000	50,727	17,086
29	Souring and Other Changes in Milk	25,000	34,172	8,379
30	Grape Diseases on the Pacific Coast		3,916	11,315
31	Alfalfa and Lucern	50,000	47,851	16,367
32	Silos and Silage		21,129	7,517
33	Peach Growing for Market	15,000	21,036	11,607
34	Meats: Composition and Cooking	15,000	23,927	11,350
35	Potato Culture	85,000	67,296	29,937
36	Cotton Seed and Its Products	10,000	19,186	11,338
37	Kafir Corn: Culture and Uses	25,000	14,685	14,503
38	Spraying for Fruit Diseases	65,000	46,534	16,006
39	Onion Culture	30,000	28,784	15,058
40	Farm Drainage		11,633	4,248
41	Fowls: Care and Feeding	50,000	37,120	5,920
42	Facts About Milk	75,000	59,243	18,876
43	Sewage Disposal on the Farm		12,307	6,921
44	Commercial Fertilizers	55,000	36,408	12,022
45	Insects Injurious to Stored Grain	25,000	20,172	5,971
46	Irrigation in Humid Climates		3,511	4,365
47	Insects Affecting the Cotton Plant	10,000	23,436	5,944
48	The Manuring of Cotton	25,000	28,568	4,188
49	Sheep Feeding	25,000	34,534	9,181
50	Sorghum as a Forage Crop	10,000	21,017	7,171
51	Standard Varieties of Chickens	100,000	90,425	33,839
52	The Sugar Beet	15,000	23,096	10,169
53	How to Grow Mushrooms		6,586	12,418
54	Some Common Birds	50,000	37,227	15,505
55	The Dairy Herd	60,000	58,423	13,260
56	Experiment Station Work—I	15,000	10,731	10,495
57	Butter Making on the Farm	65,000	56,324	24,575
58	The Soy Bean as a Forage Crop	10,000	12,221	7,620
59	Bee Keeping	16,786	24,009	14,104
60	Methods of Curing Tobacco		19,238	5,921
61	Asparagus Culture	10,000	17,888	10,638
62	Marketing Farm Produce	35,000	36,802	11,273
63	Care of Milk on the Farm	75,000	57,462	13,310
64	Ducks and Geese	45,000	37,420	17,733
65	Experiment Station Work—II	10,000	10,136	8,966
66	Meadows and Pastures	35,000	36,614	13,088
68	The Black Rot of the Cabbage	10,000	13,942	7,048
69	Experiment Station Work—III	55,000	9,792	14,372
70	Insect Enemies of the Grape		15,024	7,646
71	Essentials in Beef Production	35,000	35,250	8,093

[a] Where the number distributed is greater than the number received, the difference is accounted for by the number on hand at the beginning of the year.

Farmers' Bulletins printed, and Congressional and miscellaneous distribution, etc.—Cont'd.

No. of bulletin.	Title of bulletin.	Total number received.	Distributed to Congressmen.	Miscellaneous distribution.
72	Cattle Ranges of the Southwest	10,000	5,478	3,912
73	Experiment Station Work—IV	10,000	12,290	9,847
74	Milk as Food	25,000	26,385	12,247
75	The Grain Smuts	15,000	19,625	6,752
76	Tomato Growing	40,000	35,383	24,174
77	The Liming of Soils	30,000	13,224	16,697
78	Experiment Station Work—V		9,267	10,027
79	Experiment Station Work—VI	10,000	17,935	9,285
80	The Peach Twig-borer		12,118	6,720
81	Corn Culture in the South	55,000	37,772	11,115
82	The Culture of Tobacco	15,000	22,023	7,100
83	Tobacco Soils	10,000	11,786	4,554
84	Experiment Station Work—VII	15,000	14,228	9,715
85	Fish as Food		14,097	8,729
86	Thirty Poisonous Plants	30,000	16,839	13,587
87	Experiment Station Work—VIII		9,901	8,201
88	Alkali Lands		7,104	4,862
89	Cowpeas	35,250	31,492	16,863
91	Potato Diseases and Treatment	80,000	66,432	18,063
92	Experiment Station Work—IX		7,516	7,218
93	Sugar as Food	10,000	10,136	9,256
94	The Vegetable Garden	85,888	74,077	21,863
95	Good Roads for Farmers	105,000	91,459	26,177
96	Raising Sheep for Mutton	45,000	37,385	16,728
97	Experiment Station Work—X		8,871	7,766
98	Suggestions to Southern Farmers	45,000	42,782	6,155
99	Insect Enemies of Shade Trees	20,000	19,235	7,149
100	Hog Raising in the South	55,000	39,812	14,084
101	Millets	10,000	10,818	7,244
102	Southern Forage Plants	30,000	26,255	11,778
103	Experiment Station Work—XI		9,475	8,708
104	Notes on Frost		10,348	9,325
105	Experiment Station Work—XII		7,145	8,910
106	Breeds of Dairy Cattle	85,000	87,158	17,907
107	Experiment Station Work—XIII		13,861	10,884
108	Saltbushes		2,590	4,092
109	Farmers' Reading Courses	50,000	42,503	12,550
110	Rice Culture in the United States		5,712	3,754
111	Farmers' Interest in Good Seed	45,821	37,886	12,805
112	Bread and Bread Making	30,000	33,576	15,830
113	The Apple and How to Grow It	70,000	53,524	25,179
114	Experiment Station Work—XIV	35,000	12,655	9,836
115	Hop Culture in California		2,687	2,696
116	Irrigation in Fruit Growing	20,000	14,199	7,052
117	Sheep, Hogs, and Horses in the Northwest		8,269	4,447
118	Grape Growing in the South	15,000	17,187	6,608
119	Experiment Station Work—XV	10,000	7,740	8,457
120	Insects Affecting Tobacco	20,000	13,901	4,372
121	Beans, Peas, and other Legumes as Food	25,000	23,932	19,642
122	Experiment Station Work—XVI	10,000	9,494	8,439
123	Red Clover Seed: Information for Purchasers	35,000	23,627	7,329
124	Experiment Station Work—XVII	10,000	10,325	8,581
125	Protection of Food Products from Injurious Temperatures	15,000	12,371	5,663
126	Practical Suggestions for Farm Buildings	65,000	64,746	24,128
127	Important Insecticides	10,000	9,909	16,579
128	Eggs and Their Uses as Food	45,000	40,160	16,380
129	Sweet Potatoes	35,000	31,453	11,500
130	The Mexican Cotton Boll Weevil		13,962	8,986
131	Household Tests for Detection of Oleomargarine and Renovated Butter	15,000	9,880	4,710
132	Insect Enemies of Growing Wheat	20,000	24,890	7,191
133	Experiment Station Work—XVIII	25,000	14,032	9,508
134	Tree Planting in Rural School Grounds	40,000	27,485	10,581
135	Sorghum Sirup Manufacture	20,000	15,594	4,519
136	Earth Roads	60,000	54,344	23,909
137	The Angora Goat	35,000	20,673	18,477
138	Irrigation in Field and Garden	25,000	17,200	7,274
139	Emmer: A Grain for the Semiarid Regions		6,225	4,158
140	Pineapple Growing	10,000	4,324	4,556
141	Poultry Raising on the Farm	160,000	135,081	37,892
142	The Nutritive and Economic Value of Food	75,000	48,039	25,573
143	The Conformation of Beef and Dairy Cattle	60,000	52,617	10,500
144	Experiment Station Work—XIX	35,000	13,871	8,417
145	Carbon Bisulphid as an Insecticide		5,821	5,029
146	Insecticides and Fungicides	10,000	11,688	6,301
147	Winter Forage Crops for the South	40,000	30,640	12,301
148	Celery Culture	40,000	25,397	11,186
149	Experiment Station Work—XX	40,000	22,112	11,210

Farmers' Bulletins printed, and Congressional and miscellaneous distribution, etc.—Cont'd.

No. of bulletin.	Title of bulletin.	Total number received.	Distributed to Congressmen.	Miscellaneous distribution.
150	Clearing New Land	25,000	26,354	9,123
151	Dairying in the South	35,000	23,534	14,373
152	Scabies in Cattle	60,000	30,316	9,857
153	Orchard Enemies in the Pacific Northwest		9,991	5,126
154	The Fruit Garden: Preparation and Care	100,000	73,783	27,854
155	How Insects Affect Health in Rural Districts	30,000	16,140	8,280
156	The Home Vineyard	70,000	46,398	29,634
157	The Propagation of Plants	50,000	25,721	13,826
158	How to Build Small Irrigation Ditches	45,000	25,299	11,156
159	Scab in Sheep	40,000	22,204	20,818
160	Game Laws for 1902		7,139	3,035
161	Practical Suggestions for Fruit Growers	90,000	64,511	24,498
162	Experiment Station Work—XXI	45,000	30,905	11,284
163	Methods of Controlling the Boll Weevil	10,000	8,724	5,830
164	Rape as a Forage Crop	25,000	22,916	12,921
165	Culture of the Silkworm	25,000	6,584	19,415
166	Cheese Making on the Farm	55,000	33,401	20,964
167	Cassava	10,000	6,536	6,317
168	Pearl Millet	35,000	11,928	5,895
169	Experiment Station Work—XXII	50,000	41,664	18,075
170	Principles of Horse Feeding	150,000	134,781	45,592
171	The Control of the Codling Moth	10,000	8,413	10,416
172	Scale Insects and Mites on Citrus Trees	29,500	4,107	13,128
173	Primer of Forestry	90,000	64,525	40,495
174	Broom Corn	85,000	16,363	29,116
175	Home Manufacture and Use of Unfermented Grape Juice	50,000	24,059	24,228
176	Cranberry Culture	20,000	12,090	9,986
177	Squab Raising	60,000	33,566	38,954
178	Insects Injurious in Cranberry Culture	35,000	2,980	8,291
179	Horseshoeing	110,000	63,616	30,156
180	Game Laws for 1903	45,000	24,670	15,758
181	Pruning	75,000	45,343	20,573
182	Poultry as Food	85,000	47,677	16,887
183	Meat on the Farm: Butchering, Curing, etc	80,000	54,812	25,188
184	Marketing Live Stock	75,000	42,645	17,195
185	Beautifying the Home Grounds	60,000	43,211	16,789
186	Experiment Station Work—XXIII	50,000	25,705	18,282
187	Drainage of Farm Lands	50,000	28,824	11,286
188	Weeds Used in Medicine	55,000	20,951	17,762
189	Information Concerning the Mexican Cotton Boll Weevil	140,000	110,291	18,152
190	Experiment Station Work—XXIV	40,000	14,950	9,344
191	The Cotton Bollworm	70,000	50,777	7,299
192	Barnyard Manure	60,000	40,405	10,809
193	Experiment Station Work—XXV	30,000	6,269	7,263
194	Alfalfa Seed	30,000	8,431	8,552
195	Annual Flowering Plants	70,000	37,513	15,030
196	Usefulness of the American Toad	20,000	1,297	6,187
197	Importation of Game Birds and Eggs for Propagation	30,000	1,972	5,230
198	Strawberries	30,000		2,700
199	Corn Growing	30,000		2,694
200	Turkeys	30,000		
201	Cream Separator on Western Farm	30,000		
202	Experiment Station Work—XXVI	30,000		
		6,176,582	4,895,556	2,225,105

Publications received and distributed by the Weather Bureau during the year ended June 30, 1904, by quarters.

Number and title of publication.	Number of copies.
QUARTER ENDED SEPTEMBER 30, 1903.	
Received.	
No. 289. Monthly Weather Review for May, 1903	4,800
No. 290. Studies on the Meteorological Effects in the United States of the Solar and Terrestrial Physical Processes	500
No. 291. Monthly Weather Review for June, 1903	4,800
No. 293. Monthly Weather Review for July, 1903	4,800
Washington Daily Weather Maps	139,600
Climate and Crop Bulletins	59,800

Publications received and distributed by the Weather Bureau, etc.—Continued.

Number and title of publication.	Number of copies.
QUARTER ENDED SEPTEMBER 30, 1903—continued.	
Distributed.	
Report of the Chief of the Weather Bureau, 1896–97	12
Report of the Chief of the Weather Bureau, 1899–1900	1
Report of the Chief of the Weather Bureau, 1900–1901	2
Report of the Chief of the Weather Bureau, 1901–2	6
Separates from Report of Chief of Weather Bureau, 1891–92	2
Separates from Report of Chief of Weather Bureau, 1894	4
Separates from Report of Chief of Weather Bureau, 1895–96	5
Separates from Report of Chief of Weather Bureau, 1896–97	13
Separates from Report of Chief of Weather Bureau, 1897–98	4
Separates from Report of Chief of Weather Bureau, 1898–99	2
Separates from Report of Chief of Weather Bureau, 1899–1900	7
Separates from Report of Chief of Weather Bureau, 1900–1901	8
Separates from Report of Chief of Weather Bureau, 1901–2	35
Weather Bureau Bulletin No. 14	2
Weather Bureau Bulletin No. 16	3
Weather Bureau Bulletin No. 22	3
Weather Bureau Bulletin No. 25	20
Weather Bureau Bulletin No. 26	52
Weather Bureau Bulletin No. 28	9
Weather Bureau Bulletin No. 30	7
Weather Bureau Bulletin No. 32	8
Weather Bureau Bulletin C	12
Weather Bureau Bulletin E	3
Weather Bureau Bulletin F	1
Weather Bureau Bulletin G	9
Weather Bureau Bulletin H	11
Weather Bureau Bulletin J	2
Weather Bureau Bulletin K	10
Description of Cloud Forms	22
No. 289. Monthly Weather Review for May, 1903	4,750
No. 290. Studies on the Meteorological Effects in the United States of the Solar and Terrestrial Physical Processes	468
No. 291. Monthly Weather Review for June, 1903	4,750
No. 293. Monthly Weather Review for July, 1903	4,750
Washington Daily Weather Maps	139,600
Climate and Crop Bulletins	59,800
QUARTER ENDED DECEMBER 31, 1903.	
Received.	
No. 292. Climatology of California, Bulletin L	2,500
No. 294. Weather Folk-lore and Local Weather Signs, Bulletin 33	5,000
No. 295. Monthly Weather Review for August, 1903	4,800
No. 296. Monthly Weather Review for September, 1903	4,800
No. 297. Monthly Weather Review for October, 1903	4,800
Washington Daily Weather Maps	142,045
Climate and Crop Bulletins	15,152
Snow and Ice Bulletins	7,430
Distributed.	
Report of the Chief of the Weather Bureau, 1891–92	1
Report of the Chief of the Weather Bureau, 1893	2
Report of the Chief of the Weather Bureau, 1894	3
Report of the Chief of the Weather Bureau, 1895–96	2
Report of the Chief of the Weather Bureau, 1896–97	10
Report of the Chief of the Weather Bureau, 1897–98	1
Report of the Chief of the Weather Bureau, 1898–99, Part I	3
Report of the Chief of the Weather Bureau, 1898–99, Part II	4
Report of the Chief of the Weather Bureau, 1899–1900	3
Report of the Chief of the Weather Bureau, 1900–1901, Part I	6
Report of the Chief of the Weather Bureau, 1900–1901, Part II	10
Report of the Chief of the Weather Bureau, 1901–2	15
Separates from Report of Chief of Weather Bureau, 1894	2
Separates from Report of Chief of Weather Bureau, 1895–96	2
Separates from Report of Chief of Weather Bureau, 1897–98	10
Separates from Report of Chief of Weather Bureau, 1898–99	1
Separates from Report of Chief of Weather Bureau, 1899–1900	11
Separates from Report of Chief of Weather Bureau, 1900–1901	6
Separates from Report of Chief of Weather Bureau, 1901–2	30
Weather Bureau Bulletin No. 14	2
Weather Bureau Bulletin No. 16	2
Weather Bureau Bulletin No. 20	1
Weather Bureau Bulletin No. 22	11
Weather Bureau Bulletin No. 25	14
Weather Bureau Bulletin No. 26	23
Weather Bureau Bulletin No. 28	13

Publications received and distributed by the Weather Bureau, etc.—Continued.

Number and title of publication.	Number of copies.
QUARTER ENDED DECEMBER 31, 1903—continued.	
Distributed—Continued.	
Weather Bureau Bulletin No. 30	12
Weather Bureau Bulletin No. 31	1
Weather Bureau Bulletin No. 32	6
Description of Cloud Forms	39
Farmers' Bulletin No. 125	20
No. 290. Studies on the Meteorological Effects in the United States of the Solar and Terrestrial Physical Processes	12
No. 292. Climatology of California, Bulletin L	2,101
No. 294. Weather Folk-lore and Local Weather Signs, Bulletin 33	4,716
No. 295. Monthly Weather Review for August, 1903	4,750
No. 296. Monthly Weather Review for September, 1903	4,750
No. 297. Monthly Weather Review for October, 1903	4,750
Washington Daily Weather Maps	142,045
Climate and Crop Bulletins	15,152
Snow and Ice Bulletins	7,430
QUARTER ENDED MARCH 31, 1904.	
Received.	
No. 294. Weather Folklore, Bulletin No. 33	1,000
No. 292. Climatology of California, Bulletin L	1,000
No. 299. Monthly Weather Review for November, 1903	4,800
No. 300. Monthly Weather Review for December, 1903	4,800
Washington Daily Weather Maps	150,240
Climate and Crop Bulletins	15,020
Snow and Ice Bulletins	23,560
Distributed.	
Report of the Chief of the Weather Bureau, 1895–96	1
Report of the Chief of the Weather Bureau, 1896–97	10
Report of the Chief of the Weather Bureau, 1897–98	2
Report of the Chief of the Weather Bureau, 1898–99	3
Report of the Chief of the Weather Bureau, 1899–1900	2
Report of the Chief of the Weather Bureau, 1900–1901	5
Report of the Chief of the Weather Bureau, 1901–2	10
Separate from the Report of the Chief of Weather Bureau, 1891–92	1
Separate from the Report of the Chief of Weather Bureau, 1893	1
Separate from the Report of the Chief of Weather Bureau, 1894	2
Separate from the Report of the Chief of Weather Bureau, 1895	5
Separate from the Report of the Chief of Weather Bureau, 1896–97	3
Separate from the Report of the Chief of Weather Bureau, 1897–98	5
Separate from the Report of the Chief of Weather Bureau, 1898–99	1
Separate from the Report of the Chief of Weather Bureau, 1899–1900	5
Separate from the Report of the Chief of Weather Bureau, 1900–1901	8
Separate from the Report of the Chief of Weather Bureau, 1901–2	32
Weather Bureau Bulletin No. 1	1
Weather Bureau Bulletin No. 3	1
Weather Bureau Bulletin No. 4	1
Weather Bureau Bulletin No. 6	1
Weather Bureau Bulletin No. 7	1
Weather Bureau Bulletin No. 10	3
Weather Bureau Bulletin No. 14	1
Weather Bureau Bulletin No. 21	1
Weather Bureau Bulletin No. 22	6
Weather Bureau Bulletin No. 24	1
Weather Bureau Bulletin No. 25	7
Weather Bureau Bulletin No. 26	42
Weather Bureau Bulletin No. 27	1
Weather Bureau Bulletin No. 28	6
Weather Bureau Bulletin No. 29	1
Weather Bureau Bulletin No. 30	13
Weather Bureau Bulletin No. 31	1
Weather Bureau Bulletin No. 32	3
Weather Bureau Bulletin C	5
Weather Bureau Bulletin D	1
Weather Bureau Bulletin E	2
Weather Bureau Bulletin F	1
Weather Bureau Bulletin G	6
Weather Bureau Bulletin H	14
Weather Bureau Bulletin J	3
Weather Bureau Bulletin K	4
Description of Cloud Forms	19
No. 112. Daily River Stages	2
No. 292. Climatology of California, Bulletin L	23
No. 294. Weather Folk-lore, Bulletin No. 33	204
No. 299. Monthly Weather Review for November, 1903	4,800

Publications received and distributed by the Weather Bureau, etc.—Continued.

Number and title of publication.	Number of copies.
QUARTER ENDED MARCH 31, 1904—continued.	
Distributed—Continued.	
No. 300. Monthly Weather Review for December, 1903	4,800
No. 298. Lake Charts, 1903	928
Washington Daily Weather Maps	150,240
Climate and Crop Bulletins	15,020
Snow and Ice Bulletins	28,560
QUARTER ENDED JUNE 30, 1904.	
Received.	
Report of the Chief of the Weather Bureau for 1902–03	1,000
Bound Monthly Weather Reviews for 1903	210
No. 302. Special Climatic Charts, 1870–1901	100
Bound Washington Daily Weather Maps for 1903	200
No. 303. Bulletin M—Floods of the Spring of 1903	3,500
No. 305. Monthly Weather Review for January, 1904	4,800
No. 306. Monthly Weather Review for February, 1904	4,800
No. 307. Monthly Weather Review for March, 1904	4,800
No. 308. Monthly Weather Review for April, 1904	4,800
Washington Daily Weather Maps	137,840
Climate and Crop Bulletins	61,595
Distributed.	
Report of the Chief of the Weather Bureau, 1893	2
Report of the Chief of the Weather Bureau, 1894	11
Report of the Chief of the Weather Bureau, 1896–97	7
Report of the Chief of the Weather Bureau, 1898–99	4
Report of the Chief of the Weather Bureau, 1900–01	5
Report of the Chief of the Weather Bureau, 1901–02	10
Report of the Chief of the Weather Bureau, 1902–03	3
Separates from the Report of the Chief of Weather Bureau, 1891–92	1
Separates from the Report of the Chief of Weather Bureau, 1893	2
Separates from the Report of the Chief of Weather Bureau, 1894	1
Separates from the Report of the Chief of Weather Bureau, 1895	5
Separates from the Report of the Chief of Weather Bureau, 1896–97	2
Separates from the Report of the Chief of Weather Bureau, 1897–98	2
Separates from the Report of the Chief of Weather Bureau, 1899–00	8
Separates from the Report of the Chief of Weather Bureau, 1900–01	6
Separates from the Report of the Chief of Weather Bureau, 1901–02	83
Weather Bureau Bulletin No. 2	2
Weather Bureau Bulletin No. 5	2
Weather Bureau Bulletin No. 7	2
Weather Bureau Bulletin No. 8	2
Weather Bureau Bulletin No. 9	2
Weather Bureau Bulletin No. 14	3
Weather Bureau Bulletin No. 16	5
Weather Bureau Bulletin No. 22	4
Weather Bureau Bulletin No. 25	12
Weather Bureau Bulletin No. 26	25
Weather Bureau Bulletin No. 27	1
Weather Bureau Bulletin No. 28	4
Weather Bureau Bulletin No. 32	9
Weather Bureau Bulletin C	3
Weather Bureau Bulletin D	3
Weather Bureau Bulletin E	9
Weather Bureau Bulletin F	4
Weather Bureau Bulletin G	5
Weather Bureau Bulletin H	11
Weather Bureau Bulletin J	2
Weather Bureau Bulletin K	11
Description of Cloud Forms	11
No. 112. Daily River Stages	1
No. 292. Climatology of California, Bulletin L	9
No. 294. Weather Folk-lore—Bulletin No. 33	180
No. 298. Lake Charts, 1903	10
No. 303. Floods of the Mississippi, Spring, 1903, Bulletin M	2,606
No. 305. Monthly Weather Review for January, 1904	4,800
No. 306. Monthly Weather Review for February, 1904	4,800
No. 307. Monthly Weather Review for March, 1904	4,800
No. 308. Monthly Weather Review for April, 1904	4,800
Washington Daily Weather Maps	137,840
Climate and Crop Bulletins	61,595

REPORT OF THE STATISTICIAN.

U. S. Department of Agriculture,
Bureau of Statistics,
Washington, D. C., October 1, 1904.

Sir: I have the honor to submit herewith a report of the work of the Bureau of Statistics for the fiscal year ending June 30, 1904.

Respectfully,

John Hyde,
Statistician and Chief of Bureau.

Hon. James Wilson, *Secretary.*

REORGANIZATION OF THE DIVISION OF STATISTICS.

On July 1, 1903, the Division of Statistics of the Department of Agriculture, the oldest continuous statistical agency of the Government, antedating by twenty-two years, in work specially provided for by Congress, the creation of the Department of which for the past forty years it has formed a part, was given the broader and more elastic organization of a Bureau. Of this new organization it had stood greatly in need. The fact that its crop-reporting service, numbering nearly 250,000 persons, was a voluntary service had resulted, as it must inevitably have done, in some lack of appreciation both of the magnitude and the intricacy of its work, and it consequently remained with only a divisional organization long after such organization had ceased to enable it to do justice to the great interests intrusted to it.

For many years the development of the agricultural resources of the country was so rapid that the statistical work of the Department entirely failed to keep pace with it. Enormous additions were made to the productive area, and changes almost kaleidoscopic in their character occurred in its distribution.

NECESSITY FOR ENLARGEMENT.

It consequently became necessary to supplement the Department's long-established agencies for the collection of agricultural statistics with an active and well-equipped field force, and although something was done in this direction under the old organization, the field to be covered was so vast and the agricultural interests demanding consideration were so numerous and diversified that, while there was a general and most gratifying recognition of the fact that the Division

of Statistics was rendering an increasingly valuable service both to the agricultural and commercial interests of the country, there was a strong conviction that the machinery available was inadequate to the work required of it.

ACTION BY CONGRESS.

Finally, on the recommendation of the Secretary of Agriculture, supported by the National Board of Trade, the Southern Cotton Growers' Association, and various other commercial exchanges and agricultural associations, Congress changed the organization of the Division to that of a Bureau. The change was made in the closing hours of the Fifty-seventh Congress and was accompanied by only a very small increase in the appropriation. It put an end, however, to the uncertainty that had for some time prevailed as to the continuance of the statistical work of the Department as a separate entity and justified the reorganization of the Division on the broader basis that had so long been desired.

The Bureau of Statistics, as now organized, consists of the Division of Domestic Crop Reports, the Division of Foreign Markets, and a miscellaneous section conducting special investigations in statistics and rural economics.

WORK OF THE YEAR.

DIVISION OF DOMESTIC CROP REPORTS.

The Division of Domestic Crop Reports is under the direction of Mr. Victor H. Olmsted, a former Assistant Statistician of the Department and more recently Assistant Director of the Philippine Census.

EXTENT OF THE SERVICE.

The work of this Division forms the most conspicuous feature of the statistical work of the Department; it has employed upon it nearly two-thirds of the entire clerical force of the Bureau, and requires for the collection and compilation of its data about the same proportion of the total annual appropriation. It consists, as has frequently been stated, of a continuous inquiry into the condition of the agricultural industry, as indicated by the area of land devoted to the cultivation of the principal products of the soil; the actual volume of production and the value of particular crops, both on the farm and in the principal markets; the cost of production per acre and per unit of quantity; the number and value of farm animals and the losses of such animals annually resulting from disease and exposure, and monthly reports during the growing season on the condition of the principal crops as compared with their condition at prior dates during the same season and at corresponding dates in preceding years. Cotton is reported upon seven times, wheat eight times, corn and oats each six times, and barley, rye, buckwheat, hay and grass, potatoes, tobacco, fruit, rice, and other products from two to eight times in each year.

The results of these investigations are published monthly in the Crop Reporter, 1,319,500 copies of which were issued during the year. The principal features of the reports are bulletined in United States

post-offices throughout the entire country for the special and immediate information of farmers.

The quantitative estimates showing acreage, production, value, etc., of the principal crops of the country and the number and value of live stock therein, together with statistical tables of prices, etc., of agricultural products, all prepared in this Division, are published annually in the Appendix of the Yearbook of the Department.

There was also prepared in this Division a report on the Commercial Cotton Crop of the United States for the years 1900–1901, 1901–2 and 1902–3 by James L. Watkins. This comprehensive report shows in great detail the movement of the cotton crops of the last three years, including the number of bales shipped from each of 4,068 railroad stations and other shipping points, the consumption of cotton at the principal Southern mill points, the course of prices, cost of picking, etc. Mr. Watkins also prepared a comprehensive and interesting article on the Consumption of Cotton in the Cotton States, which was published in the Yearbook of the Department.

A not unimportant feature of the work of this Division consists of the computations it undertakes in connection with the scientific investigations of other Bureaus and Offices of the Department, such, for example, as the elaborate investigations into the effects of food adulterants recently carried out by the Bureau of Chemistry.

The method of reporting upon tobacco according to its clearly differentiated commercial types instead of by the political divisions of its area of production, as in the case of other crops, which has been put into effect this year, has met with much favor, both among tobacco planters and in commercial circles, and the work of the expert to whose well-directed efforts these results are due will be continued.

ATTITUDE OF CERTAIN COMMERCIAL INTERESTS.

The final reports of the year, issued after the crops are harvested, are usually foreshadowed with more or less accuracy by the preliminary reports published during harvest and only less closely by the condition reports issued near the close of the growing season, and their effect upon prices is consequently largely anticipated. The condition and preliminary reports, however, which at one time were practically ignored by the commercial world, are now eagerly looked for and frequently exert a profound and far-reaching influence upon the world's markets.

While the general commercial sentiment of the country, as reflected in the commercial journals and in the attitude of the exchanges, is usually just, honest, and impartial in its dealings with the Bureau's crop reports, there is a fluctuating sentiment that is favorable or unfavorable, according to the effect of the reports upon individual interests, and it is rarely that there is not some call for their discontinuance from the element that is for the time being suffering from their effect upon prices. At times the hostility aroused becomes exceedingly bitter and the most unscrupulous methods are resorted to for the purpose of discrediting the Bureau's reports. Their purport is misrepresented, their meaning is distorted, and even the integrity of those responsible for them is assailed. The records of the past three years make it clear that the more closely the Bureau's cotton estimates approximate the actual facts, as subsequently determined to the satisfaction of the entire cotton world, the more violent and per-

sistent are the attacks made upon them at the time of their first promulgation; and those records also show that neither the adoption of measures which render the premature publication of the figures, even approximately, absolutely impossible, nor even the successful prosecution in a United States court of persons who have carried their criticisms to a point where they have become libelous, will prevent or even greatly moderate the rancorous attacks of disappointed speculators and traders.

In its issue of June 4, 1904, the New York Times stated, under the striking caption "Cotton Exchange is to clean house now," that certain members of the New York Cotton Exchange having, *for the purpose of depressing the market*, circulated false and libelous reports concerning the financial standing of well-known houses, the board of managers would visit with the extreme penalty of expulsion any offender who should be found guilty of spreading such rumors. If the exchange, under a similar threat of expulsion, would compel any member claiming to be in possession of advance information concerning an official report of this Bureau to substantiate such claim and make known the source of his alleged information, it would do much to put an end to the groundless allegations that are made from time to time. Forecasts of the Bureau's figures might continue to be made by commercial statisticians and cotton houses on the strength of their own investigations, and guessing pools might continue to cover the entire range within which the official reports must inevitably fall, but the bona fide character of any legitimate commercial forecast or the nonsignificance of any mere coincidence of figures would be easily demonstrable to the satisfaction of all reasonable persons.

DIVISION OF FOREIGN MARKETS.

The Division of Foreign Markets is under the direction of Mr. George K. Holmes, its Chief at the time of its transfer to this Bureau.

The work done by this Division during the fiscal year has been almost entirely confined to the completion of certain elaborate compilations begun under a former Chief and embraced in the following bulletins: No. 30, Agricultural Imports of Germany, 1897–1901; No. 34, Agricultural Exports of the United States, 1851–1902; No. 35, Foreign Import Tariffs on Meat and Meat Products, 1903, and No. 37, Foreign Import Tariffs on Grain and Grain Products, 1903.

NEW UNDERTAKINGS ACCOMPLISHED.

With the assistance of other divisions of the Bureau, however, the Division has been able to accomplish some original work, as shown by the following list of publications: International Sugar Situation, by F. R. Rutter, Assistant Chief of Division (in press); Methods and Routes for Exporting Farm Products, by E. G. Ward, Jr., Transportation Expert of the Bureau; Wheat Production and Farm Life in Argentina, by F. W. Bicknell, Special Agent and Agricultural Explorer; Imports of Farm and Forest Products, by Countries from which Consigned, 1903; Exports of Farm and Forest Products, by Countries to which Consigned, 1903; also Circular No. 15, a preliminary and condensed statement concerning "Foreign Trade in Farm and Forest Products in 1903," and an article in the Yearbook of 1903, entitled "The Nation's Farm Surplus," by the Chief of the Division.

SUGAR AS AN INTERNATIONAL PROBLEM.

The production and sale of sugar constitute an international problem of such complicated factors as to be understood only by experts who have devoted years to their study. Attempts to furnish the public with information concerning them have been generally characterized by want of system and conciseness, by the injection of argument, and by the confusion arising from a superabundance of unimportant detail, and it is believed that there is need for a compact, lucid, and unbiased statement of the more important data concerning the production and consumption of sugar in the principal countries of the world, presented without conjecture and without argument and so that any intelligent person can acquire a comprehension of the situation.

RAILWAYS AND WATERWAYS.

The bulletin treating of the methods and routes of the exports of farm products is in line with the policy to examine for the practical uses of the public the means through which and by which the surplus products of the farm go or may go to foreign countries.

Instead of a mere alphabetical list of ocean transportation lines, as heretofore published, there has been prepared a list of foreign seaports to which ocean transportation lines have regular sailings. This information was obtained from original sources and to a large extent directly from the transportation companies themselves, instead of through customs officers.

The list of fast railroad freight lines running to Atlantic ports is another innovation which it is expected will be of considerable utility, since these are the special transportation agencies through which exports from the Atlantic ports are obtained from the interior.

ARGENTINE WHEAT.

The economic conditions attending the production of wheat in Argentina receive a comprehensive treatment in the bulletin devoted to that subject, with all the advantages of investigation on the spot. The potentialities of Argentina in the international wheat problem are, with certain qualifications, very great, and might become dominating if a sufficient supply of labor could be relied upon. The labor employed in producing Argentine wheat has so far been supplied mostly from Italy, and to a very large extent it has returned to that country at the end of the season. Besides this, it is far from being skilled agriculturally, so the land, while barely "scratched," is almost exhausted in four or five years. So far Argentina has lacked a large permanent wheat-producing population, and its future is in this respect extremely uncertain, because the present supply of labor may be greatly and permanently reduced at any time. It is a unique problem; and although Argentina is now sending large quantities of wheat to European markets, the growth of this export movement, and even its continuance, are somewhat problematical.

MISCELLANEOUS WORK.

To report periodically upon the condition and prospects of the principal crops and to promote the opening of new markets for

American agricultural products constitute the main, but not the entire, work of the Bureau. Reports on Milk Transportation and on Farm Wages have been published during the year and bulletins covering other important subjects are in course of preparation. The investigations as to the cost of certain agricultural operations on typical farms, carried on jointly with the Minnesota Agricultural Experiment Station, have been continued and a report will be issued at an early date.

In addition to the above an article on The Industry of Oil Seeds was prepared by Mr. C. M. Daugherty, of this Bureau, after an exhaustive investigation, and the same was published in the Yearbook of the Department.

WORK IN HAND.

In addition to the work reviewed briefly in the foregoing paragraphs, several other problems have been taken up for investigation and considerable progress has been made with them. Perhaps the most important is that of the world's actual and potential production of cotton.

COTTON PRODUCTION.

Although the Upland cotton crop of the United States has in recent years averaged over 10,000,000 bales, the demand for this cotton has more than kept pace with the supply, mainly because of the enlarged consumption due to increase of population and amplification of uses, but not inconsiderably on account of the mercerizing of cotton and the multiplication of fabrics made from cotton thus prepared. Fabrics made of mercerized cotton represent not merely an extension of trade along old lines, but a new trade, since these fabrics are in some degree a substitute for silk as well as for linen. Some extravagant estimates of the quantity of cotton used in the manufacture of these fabrics have been made, too extravagant to be repeated here; but it seems certain that the amount so used is considerable. Egyptian cotton is more especially used in the mercerizing process, and, although this cotton is not directly competitive with the Upland cotton of the United States, yet, indirectly, the subtraction of the Egyptian from its former manufacturing channels must leave a void to be filled from other sources.

Associations of cotton manufacturers have been organized in several European countries for the purpose of promoting the production of cotton in new lands, especially in Africa. India can not be depended upon for an adequate supply of fiber of the required grade. Egypt is unable to produce a cotton like the Upland cotton of this country, and it is not regarded as even capable of very largely increasing in the very near future the supply of the variety it now produces. It is, therefore, to the interior of Africa that European manufacturers are looking for a supply of cotton that shall render them independent of that now derived from the United States.

Concerning this subject of world-wide interest, a bulletin is in course of preparation in this Bureau. It is important that it should be known, if possible, to what extent European efforts at tropical or subtropical production are anything more than attempts to raise cot-

ton by proclamation, as was done by European manufacturers during our civil war. It is also important to ascertain to what extent native populations are or can be made available for the work of cotton production. The labor employed for this purpose must be not only able-bodied, but it must be controllable and actually controlled; it must be labor that can be depended on to work when it is required by the developments of the crop. The present condition and serviceability of the labor in the principal countries of the world in which cotton will readily grow, the labor now being actually utilized, the non-competitive character of the varieties of the cotton raised, and the various advantages and disadvantages peculiar to each country are subjects that are specially treated in the bulletin in course of preparation.

EUROPEAN GRAIN QUESTIONS.

The production and international movement of grain in the principal European countries is another subject concerning which a bulletin is well advanced toward completion. The problem is world-wide and intimately concerns the farmers of this country.

Western Europe constitutes the great market for our surplus grain. The farmers of the United Kingdom furnish only one-fourth of the wheat supply annually consumed by the vast industrial army of that country. Nearly twice as large supplies are furnished by the farmers of the United States for the English market as by the British themselves. Even Germany, only a few years ago an almost exclusively agricultural country, to-day imports one-fourth of the wheat it consumes. No less important than the study of our markets in western Europe is the study of our competitors in eastern Europe. Russia, Roumania, and Hungary are producing largely for export, and to maintain and extend our supremacy in the markets of grain-importing countries will require close study and aggressive action.

PORT FACILITIES AND OCEAN FREIGHT RATES.

An extensive and original piece of work is now in process of execution concerning the facilities of the various ocean and Gulf ports of this country for handling export farm products, and in connection with this there is also in preparation a statement of ocean freight rates, together with railroad freight rates from interior points to seaports, and the business arrangements through which the exporter at an interior point may have transportation service to foreign ports performed for him upon the simplest terms. Nothing of this sort has hitherto been prepared by either public or private agency, and it is believed that the bulletin will prove of great value.

PACKING AND GRADING FARM PRODUCTS.

Considerable work has also been done with regard to the grading and packing of farm products in this country, the weights and measures in use in this and foreign countries, and the relation between the prices of agricultural products and the quantities produced or entering into trade. These reports will all fill places not heretofore occupied.

WHERE THE WORK WILL BE ENLARGED.

During the closing weeks of the fiscal year covered by this report arrangements were made for the employment of three additional special field agents as soon as the appropriation for the fiscal year 1904–5 should become available. Experts on rice and truck have since been appointed, and these industries will now for the first time be made the subject of systematic and continuous statistical investigations by this Bureau. An additional field agent has also been assigned to the grain belt, which has been redistricted, to the great advantage of the work.

REPORT OF THE LIBRARIAN.

U. S. Department of Agriculture,
Office of the Librarian,
Washington, D. C., September 9, 1904.

Sir: I have the honor to submit herewith the executive report of the Library for the fiscal year ended June 30, 1904.

Josephine A. Clark,
Librarian.

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR.

ADDITIONS TO THE LIBRARY.

During the past fiscal year the Library has shown satisfactory growth in all branches of its work. There are now 82,375 volumes in the Library, of which number 4,135 were added during this fiscal year. The list of the most important purchases, appended to this report, includes many rare and valuable books. Every effort is put forth to make this Library not only a valuable working collection of books, but also to make its collections as complete as possible. During the past year, as in previous years, the Library has received many gifts and exchanges from authors, publishers, periodicals, institutions, and societies. A list of donors would fill many pages, and though space will not permit such a list to be given, it is hoped that all who have sent publications will accept the Library's most grateful acknowledgement. Without this help and cooperation the growth of the Library would be seriously curtailed.

PERIODICALS.

In periodicals and serial publications, including farm papers, technical and scientific journals, and serial publications of learned societies and institutions from all parts of the world, the Library is very rich, and it is in this class of accessions that its indebtedness to gifts and exchanges is most felt.

The list of current periodicals, exclusive of annual reports and proceedings of societies and institutions, now numbers 1,450, of which number 769 are sent as gifts or in exchange for Department publications. If the periodical list were extended to include annual reports and proceedings of societies it would number from 2,500 to 3,000 titles.

A constant effort is being made to increase our exchange list, with gratifying results. If the present plans can be carried out a second edition of the "Catalogue of periodicals and other serial publications in the Department Library" will be issued in 1906. It is therefore most desirable that all the publications mentioned therein should be as complete as possible. To secure this end there is urgent need of another assistant whose time can be largely devoted to the periodical work and to the preparation for the bindery of the sets that have been completed. In a library such as this, where the greatest freedom is allowed in the use of unbound numbers of periodicals, much care is necessary to keep the files complete. For the preservation of the files when complete, binding is absolutely essential.

BINDING.

During the past year the Library has bound 1,717 periodicals and separate works, an increase of 75 as compared with the number bound the previous year. It will be difficult to increase this number very materially from year to year unless, as recommended above, the time of an additional assistant can be at least partially devoted to the preparation of books for the bindery. The limited amount of money thus far available for binding has made it impossible to keep the work up to date, and each year increases the amount of unbound literature. For this reason the appropriation in the near future of a special sum to be devoted to the arrears in binding is respectfully recommended.

CATALOGUING.

During the past year the cataloguing of the current accessions to the Library has practically been kept up to date. In addition considerable progress has been made on the special catalogue of the entomological literature in the Library, which will be published during the coming year. This catalogue when completed will form the third contribution to the printed subject catalogue of the Library. As the collection of entomological books and pamphlets is very large, a catalogue of the collection will form an important contribution to bibliography and be of great service. The general card catalogue of the Library, including author, subject, and title cards, now numbers about 120,000 cards, and its usefulness is increasing each year. The printing of catalogue cards by the Library of Congress for our most important accessions is now well established. This was begun as an experiment in December, 1902, and its value not only to this Department, but to other libraries as well, has amply justified its continuance. During the time from December, 1902, to June 30, 1904, there have been printed 1,804 titles, of which number 887 were printed during the past fiscal year. Libraries possessing the books for which these catalogue cards contain descriptions can purchase them of the Library of Congress at much less cost than independent preparation by each library would require.

LIBRARY PUBLICATIONS

The publication of the quarterly bulletin entitled "Accessions to the Department Library" has been continued, and the four bulletins published during the past year comprise 229 pages.

The issuing of the index cards for Department publications has also been continued, and an increasing appreciation of these cards is shown by libraries and institutions throughout the country. A list of all the publications thus far indexed is given below.

DEPARTMENT PUBLICATIONS FOR WHICH INDEX CARDS HAVE BEEN ISSUED.

Yearbooks 1894–1902.
Farmers' Bulletins 1–177.
Reports 1–32, 34–72.
Miscellaneous special reports 1–10.
Special reports 1, 3, 4, 11, 12, 18, 22, 26, 28, 31, 33–36, 40, 47, 48, 50, 54, 55, 62, 63.
Bureau of Plant Industry: Bulletins 1–26, 28–50.
Division of Accounts: [Special reports] 1894–1898.
Division of Agrostology: Bulletins 1–24; Circulars 1–36.
Division of Botany: Bulletins 1–29; Circulars 1–30; Contributions from the United States National Herbarium, vols. 1–7.
Division of Pomology: Bulletins 1–10; Circulars 1–3; Nut culture; Reports of the Pomologist, 1886–1900.
Division of Soils: Bulletins 1–16; Circulars 1–7.
Office of Fiber Investigations: Annual Reports, 1890–1897; Reports 1–11; United States Flax and Hemp Commission Report.
Office of Public Road Inquiries: Bulletins 1–25; Circulars 14–36; Reports of Director, 1893–1902.
Section of Seed and Plant Introduction: Inventories 1–8; Circulars 1–2.

The work in connection with the distribution of the cards has now become so great that the service of an additional assistant in this work is urgently needed if the distribution as well as the preparation of the cards is to be continued by the Department.

INDEXING AGRICULTURAL LITERATURE.

In addition to the indexing of Department publications the Library has begun the indexing of important agricultural periodicals. An announcement concerning this work was given in the report of the Librarian for 1903. The periodicals thus far indexed are Annales de la Science Agronomique, 1884–1903; Die Landwirthschaftlichen Versuchsstationen, vols. 1–57, 1859–1902, and Landwirthschaftliche Jahrbücher, vols. 1–31, 1872–1902. Arrangements have been made with the Library of Congress for the printing and sale of these cards, and they will be available for distribution by December, 1904.

COOPERATION WITH OTHER LIBRARIES.

One of the main features of library work at the present time is cooperation between libraries, as shown in cooperative bibliographical work and in mutual lending. The publication in 1901 of "A union list of periodicals, transactions, and allied publications currently received in the principal libraries of the District of Columbia, compiled by the Library of Congress," did much toward making the periodical resources of the different Washington libraries more available. An extension of such cooperative bibliographical work is most desirable. This Library has made frequent use of the Library of Congress, the Surgeon-General's Library, the Patent-Office Library, and the United States Geological Survey Library, and the courtesies received have been greatly appreciated. Especial thanks are due to the first two libraries, with whom a regular loan service has been carried on. The average number of books borrowed by this Library from the Library of Congress during the months from January to July,

1904, was 71 a month; the average number borrowed from the Surgeon-General's Library for the same time was 37. Our Library has made frequent loans of books to other libraries, especially to the libraries of the State experiment stations and agricultural colleges and also to officers and students connected with these institutions. It has been the aim of the Library to be of assistance to the above institutions in every way possible.

RECOMMENDATIONS.

In order that the work of the Library may progress and that it may fulfill more nearly the demands made upon it, a favorable consideration of the arguments accompanying the Librarian's estimates for the year 1905–6 is most strongly urged. As the Department grows the Library should grow, and with this growth there must necessarily be an increased appropriation for the management, care, and preservation of this valuable collection of books, so essential in the work of the Department.

IMPORTANT PURCHASES DURING THE FISCAL YEAR ENDED JUNE 30, 1904.

Annesley, Hugh Annesley, *5th Earl.* Beautiful and rare trees and plants. With seventy illustrations from photographs taken at Castlewellan. 97 p. plates. London, 1903.

Beddome, Richard Henry. Icones plantarum Indiæ orientalis, or Plates and descriptions of new and rare plants from southern India and Ceylon. 70 p. 300 plates. Madras, 1874.

The Botanist; containing accurately coloured figures of tender and hardy ornamental plants. . . . Conducted by B. Maund, assisted by the Rev. J. S. Henslow. 5 v. col. plates. London [1838–46?].

Brotero, Felix de Avellar. Flora lusitanica, seu, Plantarum, quæ in Lusitania vel sponte crescunt, vel frequentius coluntur, ex florum præsertim sexubus systematice distributarum, synopsis . . . 2 v. Olissipone, 1804.

Bryden, Henry Anderson, *ed.* Great and small game of Africa; an account of the distribution, habits, and natural history of the sporting mammals, with personal hunting experiences. 612 p. col. plates. London, 1899.

Cavanilles, Antonio José. Monadelphiæ classis dissertationes decem. 3 v. 296 plates. Matriti, 1790.

Corda, August Carl Joseph. Flore illustrée de mucédineés d'Europe. 55 p. 25 plates. Leipzig, 1840.

The Encyclopedia Americana; a general dictionary of the arts and sciences, literature, history, biography, geography, etc., of the world.

Evans, Charles. American bibliography . . . a chronological dictionary of all books, pamphlets, and periodical publications printed in the United States of America from the genesis of printing in 1639 down to and including the year 1820, with bibliographical and biographical notes. v. 1, 1639–1729. Chicago, 1903.

Farnham, Henry Philip. The law of waters and water right; international, national, state, municipal, and individual, including irrigation, drainage, and municipal water supply. 3 v. Rochester, 1904.

Friedberger, Franz, and Fröhner, Eugen. Lehrbuch der speziellen Pathologie und Therapie der Haustiere. 6. verb. und verm. aufl. 2 v. Stuttgart, 1904.

Hareux, Ernest Victor. Les arbres, leur différentes essences; arbres de haute futaie, études d'après nature, montrant l'ensemble et les détails des principaux arbres, dont la connaissance exacte, au point de vue de la forme, est indispensable aux peintres, sculpteurs, dessinateurs, graveurs, décorateurs, architectes, jardiniers, etc., comme à tous qui s'intéressant aux arts et à la nature, pour leur utilité professionnelle ou leur agrément. [16 p.] 32 plates. Paris, 1902.

Hedin, Sven Anders. Central Asia and Tibet, towards the holy city of Lassa. 2 v. London, 1903.

Holmskjold, *originally* Holm, Theodor. Beata ruris otia fungis dancis impensa. 2 v. 75 col. plates. Havniea, 1799.

Hooker, *Sir* William Jackson. The British Ferns; or, coloured figures and descriptions with the needful analyses of the fructification and venation of the

ferns of Great Britain and Ireland, systematically arranged. . . . The drawings by Walter Fitch. unp. 66 col. plates. London, 1861.

Hooker, *Sir* William Jackson. A century of ferns: being figures with brief descriptions of one hundred new, or rare, or imperfectly known species of ferns, from various parts of the world; a selection from the author's "Icones plantarum." 98 leaves. 100 col. plates. London, 1854.

Lavallée, Alphonse, *i. e.*, Pierre Alphonse Martin. Arboretum Segrezianum. Icones selectæ arborum et fruticum in hortis Segrezianis collectorum. Description et figures des espèces nouvelles, rares ou critiques de l'Arboretum de Segrez . . . 121 p. 36 plates. Paris, 1885.

Linnæus, Karl von. Entomologia, Faunæ suecicæ descriptionibus aucta; DD. Scopoli, Geoffrey, de Geer, Fabricii, Schrank, etc., speciebus vel in systemate non enumeratis, vel nuperrime detectis, vel speciebus Galliæ Australis locupletata generum specierumque rariorum iconibus ornata; curante et augente Carolo de Villers . . . 4 v. Lugduni, 1789.

Lydekker, Richard. The great and small game of India, Burma, and Tibet, with contributions by sportsmen. 416 p. 9 col. plates. London, 1900.

Macquart, Justin, *i. e.*, Pierre Justin Marie. Insects diptères du nord de la France . . . 5 v. 21 plates. Lille, [1823–33].

Märcker, Max, *i. e.*, Heinrich Maximilian. Max Maerckers handbuch der spiritusfabrikation. 8. vollständig. neubearb. aufl., hrsg. von Dr. Max Delbrück . . . 940 p. plates. Berlin, 1903.

Miers, John. Illustrations of South American plants. 2 v. 87 plates. London, 1849–57.

Naples—*Regia universita degli studi- Museo zoologico.* Annuario del Museo zoologico della R. Università di Napoli, per Achille Costa . . . 1861–66, anno 1–6. plates. Napoli, 1862–71.

Poole's index to periodical literature. 4th Sup., from January, 1897, to January 1, 1902, by William I. Fletcher and Mary Poole. 646 p. Boston, 1903.

Schmidt-Göbel, Hermann Max. Faunula Coleopterorum Birmaniæ, adjectis nonullis Bengaliæ indigenis. 94 p. 3 plates. [Prag, 1846.]

Spencer, Herbert. An autobiography. 2 v. New York, 1904.

Swainson, William. A selection of the birds of Brazil and Mexico. 4 p. 78 col. plates. London, 1841.

Sweet, Robert. The British flower garden; containing coloured figures and descriptions of the most ornamental and curious hardy herbaceous plants, including annuals, biennials and perennials, with their scientific and English names; best method of cultivation and propagation; the heights they generally attain . . . The drawings by E. D. Smith . . . 3 v. 300 col. plates. London, 1823–29.

—— The British flower garden (series the second) containing coloured figures and descriptions of the most ornamental and curious hardy flowering plants; or those that are somewhat tender . . . The drawings by E. D. Smith . . . 4 v. 412 col. plates. London, 1831–38.

Vahl, Martin. Eclogæ americanæ, seu Descriptiones plantarum præsertim Americæ meridionalis, nondum cognitarum . . . 3 v. 30 plates. Hauniæ, 1796–1807.

—— Symbolæ botanicæ, sive Plantarum, tam earum, quas in itinere, primis, orientali, collegit Petrus Forskal . . . 3 pt. 75 plates. Hauniæ, 1790–94.

Viviani, Domenico. Floræ libycæ specimen, sive, plantarum enumeratio Cyrenaicam, Pentapolim, magnæ Syrteos desertum et regionem tripolitanam incolentium quas ex siccis speciminibus delineavit, descripsit et ære insculpi curavit Dominicus Viviani. 68 p. 27 plates. Genuæ, 1824.

Walckenaer, Charles Athanase, *baron.* Histoire naturelle des aranéides . . . unp. 50 col. plates. Paris, 1806 [–08].

Wallich, Nathaniel. Plantæ asiaticea rariores; or Descriptions and figures of a select number of unpublished East Indian plants . . . 3 v. 295 col. plates. London, 1830–32.

Watson, William. Orchards: Their culture and management. New ed., rev. throughout and greatly enl. 559 p. 20 col. plates. London, 1903.

Weinstein, Bernhard. Thermodynamik und kinetik der körper . . . 2 v. Braunschweig, 1901–03.

Willkomm, Heinrich Moritz. Illustrationes floræ Hispaniæ insularumque Balearium. Figures de plantes nouvelles ou rares décrites dans le Prodromus floræ hispanicæ ou récemment découvertes en Espagne et aux Isles Baléares, accompagnées d'observations critiques et historiques . . . 2 v. in 1. 188 col. plates. Stuttgart, 1881–92.

REPORT OF THE DIRECTOR OF THE OFFICE OF PUBLIC ROAD INQUIRIES.

U. S. Department of Agriculture,
Office of Public Road Inquiries,
Washington, D. C., September 10, 1904.

Sir: I have the honor to submit herewith the report of the Office of Public Road Inquiries for the fiscal year ending June 30, 1904, together with an outline of the work for the current year and recommendations and estimates for the ensuing year.

Respectfully,

Martin Dodge, *Director.*

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR.

During the fiscal year 1903–4 a deep and widespread interest in the road question has manifested itself in all sections of the country, and this Office has been called upon for assistance, information, and advice in ever-increasing measure. So far as the limited appropriation would permit this demand has been met, with most satisfactory results. In some cases short sections of object-lesson roads were constructed in cooperation with the local authorities, this feature of the work having received especial attention. In other cases, where it was not practicable to give instruction by the object-lesson method and where oral instruction would serve the purpose, men especially qualified by experience, research, and natural ability to deal with the special questions arising were sent out to examine material, to deliver lectures and addresses, and to render all assistance possible in the way of advice and suggestion. Stereopticon views have been used to great advantage in illustrating many of the lectures given, each step in the construction of a model road and the cross section of a finished road being thus accurately depicted. These were supplemented by comparative views of good and bad roads and of typical roads in various sections of the United States and in foreign countries.

In many parts of the country suitable materials for good roads, constructed according to established principles, are obtainable only at great expense. To overcome this difficulty is one of the chief aims of the Office; and, with that end in view, experiments and research are now being carried on; mineral oil, sand-clay, burnt clay, and gumbo are receiving particular attention.

The demand for the publications of the Office has been unprecedented in volume during the past year, coming not only from all sec-

tions of the United States, but from Porto Rico, Hawaii, the Philippines, and foreign countries. According to advices received much good has been done by the distribution of this literature in awakening an interest in road improvement and in directing efforts along proper lines.

One of the greatest drawbacks to effective effort for the improvement of the common roads is lack of organization and united effort on the part of those concerned. To meet such conditions assistance has been given in organizing conventions and directing the attention of the people to the importance and feasibility of better roads. This work has borne rich fruit in the shape of many thousands of dollars wisely spent in highway improvement.

NATIONAL SCHOOL FOR ROAD BUILDING.

The calls for experts and engineers skilled in road building are numerous and urgent. It therefore seems advisable to repeat and strongly emphasize the recommendation made last year on this subject, as follows:

Public sentiment in favor of better roads has grown so rapidly within the last few years that a number of the Eastern States and many counties, parishes, townships, towns, and districts in the Central, Southern, and Western States, have raised sufficient funds to improve some of the leading highways. In many of the Southern and Western States these funds are being injudiciously expended on account of a lack of intelligent and skilled supervision. This Office is being constantly appealed to for experts and engineers skilled in the art of road building to take permanent charge of State and county work, and the demand for such men far exceeds the supply. Several of the technical colleges of the country are turning out each year a large number of civil engineers, but most of them know little or nothing about practical road building. It would, therefore, seem advisable that in connection with the Office of Public Road Inquiries there should be established in Washington a post-graduate school, where graduates in civil engineering could secure a thorough course in theoretical and practical road building. A similar school was established in Paris by the Government of France in the year 1747, and the condition of French roads to-day attests the wisdom of such action. The American school of road building should include a series of lectures by experts of this Office, and some practical work in the road-material laboratory and in connection with the object lesson and experimental road work of the Office in different parts of the country.

PUBLICATIONS OF THE OFFICE.

One bulletin, two Yearbook articles, and one circular were issued during the year.

Bulletin No. 26 contained the Proceedings of the National Good Roads Convention, held at St. Louis, Mo., April 27–29, 1903. The convention was addressed by President Roosevelt, members of Congress, governors of States, officers of the Army, presidents of universities, and others. It was the largest and most important road convention ever held in the United States. The bulletin contains many valuable addresses and much practical information relating to highway improvement, which will be of interest throughout the country.

Building Sand-Clay Roads in the Southern States is the title of an article published in the 1903 Yearbook, and prepared by W. L. Spoon, special agent of this office. Mr. Spoon has been experimenting with sand-clay roads in the Southern States for a number of years, and this article contains the results of his investigations. In view of the fact that durable roads can be built of a mixture of sand and clay in those sections of the country where little or no frost occurs, there has been a wide demand for Mr. Spoon's article and for his services in inaugurating the construction of sand-clay roads in many sections of the South. Richland County, S. C., has about 400 miles of sand-clay road out of 650 miles in the county. These roads have given entire satisfaction, and

have stood the test of hard rains and constant traffic. The cost varies from $300 to $600 per mile, depending upon the amount of grading done and the distance the sand and clay have to be hauled.

Progress of Road Building in the Middle West is the subject of an article written for the Yearbook for 1903 by R. W. Richardson, special agent for the Middle Western Division. The article contains many practical suggestions as to the ways and means of building improved roads. The road laws of the Middle Western States are discussed and also the condition of the roads, methods of road construction, and materials used in road building. Great progress has been made in all the Middle Western States during the last few years, much progressive legislation has been enacted, and a great deal of practical work inaugurated.

Circular No. 37, entitled The Railroads and the Wagon Roads, was written by Mr. A. L. Craig, general passenger agent of the Oregon Railway and Navigation Company. It was read by Mr. Craig at the Oregon State Good Roads Convention at Portland, October 24, 1903, and the convention unanimously requested its publication as a circular of this Office. This paper deals with some features of the road question not heretofore presented in publications of this Office, and relates principally to the economic results which follow road improvement and the relation which exists between the railroads and the wagon roads.

WORK OF THE SPECIAL AGENTS OF THE OFFICE.

The following reports in detail show the work done under the supervision of the special agents of the Office in charge of the four divisions:

SOUTHERN DIVISION.

The work for the Southern Division has been carried on during the year under the supervision of Prof. J. A. Holmes, special agent, with headquarters at Chapelhill, N. C., assisted by Mr. W. L. Spoon. Good-roads conventions have been held in different States, addresses have been delivered at a number of points, and many newspaper articles have been prepared and published. Under the direction of Mr. Spoon, a number of experiments have been conducted in the rockless areas in connection with the improvement of the earth roads by admixtures of sand and clay; and with the aid of Mr. R. H. Sykes, of the North Carolina geological survey, a number of special press bulletins have been printed and distributed to prominent newspapers and to citizens in all of the Southern States. In practically all of these States the interest in road betterment has been growing slowly but continuously. The old labor system is gradually giving place to the more modern, more enlightened, and more practicable system of improving roads by taxation. The legislation relative to this subject has become yearly more favorable to larger expenditures and more satisfactory work in behalf of good roads. The number of convicts employed at road building in the different States has steadily increased in all sections where the system has been placed upon a practicable basis, and this use of the convict force has done much to help along the movement for good roads in all this region.

Professor Holmes and his assistants have done everything that the appropriation at their disposal would permit in the way of organizing this movement and leading it forward. Beneficial results are appearing in the steadily increasing mileage of good roads in each of the States of this Division.

One of the most satisfactory illustrations of the progress toward better roads is to be found in the State of Maryland, where the legislature in 1898 authorized the Maryland geological survey to make a report on the condition of the public roads and the methods of their

administration throughout the State, and for the support of this work made an appropriation of $10,000 a year. This appropriation was continued for several years following, and, as an evidence of the continued development of this work, in the early spring of 1904 the legislature appropriated the sum of $200,000, and enacted legislation making this sum annually available for the permanent improvement of highways. These funds are to be allotted to the counties on condition that any county which receives an allotment shall raise by taxation and expend an equal amount.

In North Carolina, during the year 1903, a single county, namely, Guilford, raised by bond issue the sum of $300,000; and in a number of other counties special taxes have been levied and many miles of permanent stone roads have been constructed every year. In the eastern counties, moreover, considerable progress has been made in the mixture of sand and clay in road building. The results obtained are proving highly useful in connection with road building in rockless areas, as a guide and stimulus for the construction of public roads.

In the road-building movement the strongest influences have naturally been in and about the larger and wealthier cities, and in each of the Southern States the number of miles of permanent roads about these centers is increasing steadily.

Another important factor in the improvement of roads in the South has been the use of convict labor in public-road construction. In the two Carolinas, Georgia, Tennessee, Kentucky, and Texas (and to a less extent in other States) this use of convict labor has passed beyond the experimental stage, and its employment has cheapened the cost of road building and thereby stimulated the good-roads movement.

As an illustration of the progress of road improvement in the South, the following statement as to the number of miles of improved roads that have been constructed in different States is worthy of consideration:

ALABAMA.—About 1,000 miles of gravel (including chert) roads and 300 miles of stone roads.

FLORIDA.—Two hundred miles of shell and gravel roads and 150 miles of stone roads.

GEORGIA.—One thousand one hundred miles of gravel roads; more than 200 miles of stone roads.

KENTUCKY.—Two thousand miles of gravel roads; 5,600 miles of stone roads, mainly built as toll roads, but now free.

NORTH CAROLINA.—Four hundred miles of gravel roads; 300 miles of stone roads.

TENNESSEE.—One thousand two hundred miles of gravel roads; 1,000 miles of stone roads.

VIRGINIA.—Three hundred miles of gravel roads; 550 miles of stone roads (mainly built as toll roads).

During the year Mr. Spoon has been employed in investigating and experimenting with the various deposits of sand and clay, with a view to determining the economic value of such deposits for road-building purposes.

During the month of July, 1903, Mr. Spoon taught a class in road building at the summer school at the Agricultural and Mechanical College, Raleigh, N. C., and made frequent visits with the class to the

roads then under construction near Raleigh, pointing out the essentials of road building.

The following are examples of the object-lesson work done under the direction of Mr. Spoon:

NEWBERN ROAD.—This road is in Craven County, N. C., just outside the corporate limits of Newbern. It was constructed of sedimentary clay and very fine sand, carrying more or less vegetable matter. This road withstood public travel until the extreme winter rains thoroughly soaked it, when it became soft and cut up in places. The addition of sand has improved it, and now, instead of deep sand in dry weather, it is exceedingly hard and smooth, requiring only scraping when the spring weather sets in; and then for eight months in the year it is fine. The road was covered 8 to 10 inches with clay and then 6 inches of sand at the first application. This road, of which nearly 3 miles were built, cost about $700 per mile. It was not rolled. Carts, plows, shovels, and scrapers were the only tools used in its construction.

LAKEVIEW ROAD.—This road was built at Lakeview, N. C., and was also made of sand and clay. No clay was hauled. The sand and clay were merely crowned properly with a road machine. This object-lesson road was made upon the cheapest plan, to show what can be done by simply crowning the material at hand. In this instance a thoroughly satisfactory road resulted because of the excellent combination of sand, gravel, and clay, which needed only crowning to make a good road.

ELKIN STREETS AND ROAD.—This work was done by the town of Elkin, N. C., under the direction of Mr. Spoon. The principal street was graded through the town and macadamized. The plan was to do this work as an object lesson to the surrounding district. The stone used was mica-schist and quartzite, put down in three courses—6 inches of 2½-inch stone and 3 inches of 2-inch stone, each course rolled separately, and all remaining spaces filled with dust and rolled.

WORK AT SMITHFIELD, N. C.—Mr. Spoon spent several days in Johnson County, N. C., with the township road commissioners, going over the roads and discussing with them practical methods of road improvement and actually demonstrating the proper use of the local material. As a result of his work and the efforts of the commissioners a convict force has been organized and the roads are now ditched and crowned in every section of the township. One hundred miles have been so worked and made good dirt roads for less than $2,500 by the use of convict labor and the road machine.

In addition to the above, Mr. Spoon has done a large amount of valuable work, addressing farmers' institutes and other gatherings, conducting correspondence, distributing literature, and examining quarries of stone and deposits of gravel.

During the year Col. J. B. Killebrew, special agent of this Office, rendered valuable assistance in the Southern Division by lectures and addresses dealing with the economic and financial phases of the road question—ways and means of providing the necessary funds requiring thoughtful consideration and study as much, perhaps, in many cases, as the methods of construction. Colonel Killebrew also advised with State officials and legislative bodies in various parts of the Southern Division.

CENTRAL DIVISION.

The local work done in northern Ohio during the year has been continued under direction of Mr. J. F. Brown, special agent, and included finishing the Russell road and constructing three other roads of the same general character; also constructing two limestone roads, as further described below.

BAINBRIDGE ROAD.—This road is in Bainbridge Township, Geauga County, Ohio, and is a main road leading to the village of Chagrin Falls and subject to

very heavy travel at all times of the year. The soil is a heavy yellow clay with occasional soft places indicating springs. The material used was field sandstones, broken by hand on the work, and the local granite bowlders gathered from the fields, blasted to a size for handling, then run through the crusher, and screened to size. The product of the crusher, after being screened to size, was carried by elevator belt delivering to screens, then into separate bins according to size of crushed stone. Material was put on in courses by automatic dumping and spreading carts. The machinery used was a No. 4 rock crusher, two distributing wagons, and a 12-ton steam roller. The use of this machinery eliminates much of the hand labor. The road was excavated 8 inches deep and 9 feet wide with the road machine to form shoulders of clay to prevent the stone from spreading, the excavated material being used to form the earth road alongside. The first course was 5 inches deep, of common field stones rolled to a firm bearing; second course, granite from crusher, 2½-inch size, rolled solid; third course, 1½-inch size crushed granite, rolled; top course, 1-inch size and screenings, washed in and thoroughly rolled and sprinkled, the roller being used freely till it made no impression, and the whole mass was perfectly bonded. This road was begun August 27 and work was suspended September 27, 1903, to allow the force to build the object-lesson road at Oak Harbor, Ottawa County. Work was resumed in the spring of 1904 and finished in July following. The part finished September 27, 1903, stood well through the winter without any perceptible changes, being hard and smooth in the spring. Observation shows that the operation of the roller on this road finally reduced the depth of broken stone 20 per cent, so that it was about 10 inches deep when finished. Material was abundant and within easy reach. The cost of this road was approximately $3,000 per mile. The progress of the work when everything was in good working order was 200 to 300 linear feet per day.

Oak Harbor road.—This road is in Carroll and Salem townships, Ottawa County, Ohio. The soil is a deep clay loam, working into a sticky mass, making the road almost impassable in wet weather. The object-lesson road was begun October 4, 1903, and is 1 mile long. The material used was crushed limestone, obtained at the quarry at Bellevue, brought by rail 17 miles, and then hauled by teams to the road, the average haul being 2 miles. This is a double-track road—one track macadam 9 feet wide and 10 inches deep, and the other earth 8 feet wide. The crushed stone was screened at the quarry into three grades, and the process of construction was the same as that employed in building the Bainbridge road. Work on this road began October 4 and was completed November 20, 1903. Experience with this road goes to show that an object-lesson road in this kind of soil should be built earlier in the season, in order to give the stone time to bond before cold weather comes. On account of the extremely sticky nature of the mud at its worst, the tendency developed to "pick up," to some extent, at the crossroads, where teams came onto the macadam road with the wheels of the wagons loaded down with mud; consequently, some repairs became necessary at those points. Since observing the working of this road and the peculiar nature of the soil, Mr. Brown is of the opinion that the macadam road should be made wider and placed in the middle part of the roadway; and that at the crossings of other roads there should be placed rough stones for some distance to jar the mud from the wheels before reaching the macadam road.

Chagrin Falls road.—This road is an extension of the Russell road, described in my report for 1903, and runs to the corporation line of Chagrin Falls village. It is built the same as the Russell road, the same machinery and material being used. It is 2,465 feet long, was begun August 10, 1903, was finished on the 23d of the same month, and cost $2,000. The increased cost is due to the extra amount of grading required. Material was convenient, but required blasting and hauling uphill. The width of the stone road is 9 feet, and the courses of stone were laid and rolled the same as in case of the Bainbridge road.

Rocky River road.—This road was built by the village of Rocky River, in Cuyahoga County, and extends from the western end of the river bridge to the railroad depot, a distance of about 800 feet. Mr. Brown designed this road for very heavy travel to and from the depot. It was built in the fall of 1903 of limestone from the quarries at Bellevue, Ohio. The machinery used was a 13-ton roller and a sprinkling wagon. The material was put on to a thickness of 15 inches before rolling in the usual form of separate courses and each course well rolled and bonded, the width being 24 feet. No curbing was used. The road surface became smooth and hard and resisted the heavy traffic, consisting

of loads of stone, timber, and other building material, without any show of unequal wear or settlement. No full details of cost have been obtained. The price of stone, delivered on cars at the depot, which is the same for Cleveland and vicinity, was $1 per ton, crushed and screened to size. The probable cost of such a road in the Cleveland district would be about $8,500 per mile if built economically, and it would be an excellent road for heavy traffic.

GENERAL OBSERVATIONS.—A few general observations by Mr. Brown as to the methods sometimes pursued in road work, and especially in commencing road improvements which are sure to lead to bad results are here noted:

The practice of building a macadam road on the side of roadway, leaving the earth road lower alongside, is not recommended. A better plan in heavy clay soil is to excavate with the road machine the width of the macadam road and half its depth for a subgrade, using the material taken out for the earth road alongside, bringing the road to a crown in the center, with earth and macadam roads of the same elevation, using shoulders of clay to sustain the macadam road at the sides.

The No. 4 crusher used was too light for the granite bowlders of northern Ohio. More strength and capacity and a rearrangement of screens are required.

The practice of trying to build macadam roads without a steam roller is a waste of time and money, as the very object of building the road is defeated. The rain water penetrates the road everywhere and it soon works into ruts and holes under traffic. A heavy horse roller or a 200-pound hand hammer would be better than nothing. Too much sprinkling, causing a shifting or wave-like motion under the roller, is injurious and should be avoided.

Material for road construction in northern Ohio is divided into the following general classes: (1) Granite bowlders, generally known as "nigger heads," supposed to have been deposited by glacial drift, which are the very best; (2) limestone in northern Ohio from Bellevue, Genoa, Marion, and Columbus (some of the dolomites), which possesses a high degree of cementing power and wears very well; (3) limestone from central and southern Ohio (carboniferous) from the Mahoning Valley, at Lowellville and Youngstown points, the best of this class.

The average cost of this kind of stone at the quarry, crushed and screened to size, is 60 cents per ton. Railroad delivery costs from 30 to 50 cents per ton. Delivering by teams on the work costs from 40 to 60 cents per ton. The cost of rolling and sprinkling may be roughly estimated at 5 cents per ton. The amount of stone, varying within small limits, for a macadam road 9 feet wide may be estimated at 3,000 tons per mile. The net first cost of such roads may be generally estimated as follows: When built of crushed bowlders near the work, including cost of blasting large ones, from $2,200 to $2,800 per mile, including the grading, etc.; when built of imported material, from $3,600 to $4,000 per mile. The cost of roads of greater width for heavy traffic near towns, etc., will be greater in proportion to the width.

The practice of placing all kinds of gravel on roads to a depth of 8 to 12 inches or more is not recommended. A gravel road should have a broken-stone base well consolidated by rolling, then selected cementing gravel should be put on in courses and thoroughly rolled and sprinkled to a finish.

MIDDLE WESTERN DIVISION.

During the year Mr. R. W. Richardson, special agent in charge, was actively engaged in compiling statistics relative to roads and road improvement throughout the Middle Western Division, addressing representative bodies, and advising with road officials. The thoroughness of his work of research is evidenced by the article published in the Yearbook of the Department for 1903, entitled, Progress of Road Building in the Middle West, embodying the results of the investigations carried on by him during a considerable portion of the year.

Mr. Richardson also prepared a paper on The Relation of Good Roads to Commerce, and presented the same before the Trans-Mississippi Commercial Congress, in session at Seattle, Wash. This paper was widely circulated through the press.

A number of good-roads conventions were organized by Mr. Richardson; and several State meetings, some of which favorably influenced subsequent road legislation, were largely due to his efforts. A State meeting was held in Iowa, as an outcome of which a State board of highway commissioners was appointed. Interest has increased in that State, and improved methods for providing the means for road building have been adopted. The earth roads have been improved, and there has been a considerable increase in the mileage of permanent roads.

A large and representative convention was held in the State of Arkansas; and the legislature later provided for increased revenues for road purposes in the State.

A State good-roads meeting was held at Dallas, Tex., in March, 1903. Dallas County voted $600,000 in bonds for road improvement and is now building a fine system of roads.

Progress has been made in Kansas as a result of work done in that State. The counties in which Topeka and Fort Scott are located are building and extending permanent roads.

In April, 1904, the annual State good-roads convention was held at Waco, in McLennan County, Tex. This was well attended, and was addressed by the governor and many other prominent men. As proof of the beneficial results of the meeting held at Dallas the year previous, Mr. Richardson was taken on a tour of inspection of 7 or 8 miles of beautiful macadam road by Road Supervisor Bird, of McLennan County, who assured him that this road has been built as a direct result of the inspiration and practical and technical knowledge he had received at the Dallas meeting.

The object-lesson road work of this Office received careful attention at the hands of Mr. Richardson, who perfected arrangements for an object-lesson road at Fort Smith, Ark., and another at Batesville, Ark. He also had entire charge of the arrangements for the object-lesson road built on the grounds of the Louisiana Purchase Exposition at St. Louis, and arranged the proceedings of the National and International Good Roads Convention at St. Louis in 1904, including "Good Roads Day" on the Exposition grounds, May 19, 1904.

During the year Mr. Richardson has written many articles on modern methods of road construction for the press, including commercial and agricultural journals.

ROCKY MOUNTAIN AND PACIFIC COAST DIVISION.

During the year Mr. James W. Abbott worked in the States of Colorado, Utah, Idaho, Washington, Oregon, and California, and the Territory of New Mexico. His efforts were devoted to giving expert technical advice regarding improved methods of road building to men intrusted with the responsibility of constructing them.

At the request of the State engineer of Colorado, in company with the officers designated by law to build with State funds six mountain roads, he made a careful reconnoissance of and report on each route, advising specifically as to every detail of location and construction.

In California a movement was inaugurated to reconstruct and beautify El Camino Real, the old route followed from San Diego northward by the Franciscan monks from mission to mission while

California was Mexican territory, and culminated in a great State convention at Santa Barbara in April last, at which an organization was perfected to carry forward this work. The road contemplated in carrying out this enterprise will be nearly 700 miles in length. At the request of those who were working to start the enterprise, Mr. Abbott devoted considerable time to assisting in shaping the details.

In New Mexico a mountain road from Las Vegas to Santa Fe, destined to become famous because of scenic attraction and excellence of construction, is being built by convict labor. At the request of the authorities in charge Mr. Abbott inspected this road and advised with them. The distinguishing importance of this road will probably be the fact that it will demonstrate the correct theory of using convicts in highway construction.

Mr. Abbott visited very many points widely separated, generally by specific request, and advised the proper officers concerning road construction. By request he addressed 12 conventions on road building, dealing principally with the technical questions involved. As heretofore, he contributed to periodical literature, in this also treating generally some practical feature of the question.

Mr. Abbott's field differs radically from the other divisions. Most of it is sparsely settled. Counties are large and their revenues small. Many counties are larger in area than several Eastern States combined. More than one-half of this enormous area is mountainous, much being very rugged, and a large proportion arid or semiarid. The range of road problems presented is much greater than in all the rest of the United States put together. Directly as the result of the campaign of education carried on in recent years by the Office of Public Road Inquiries there is now an insistent demand for light and aid in securing better roads. In at least nine-tenths of this region, owing to physical conditions, it is impracticable for this office to construct object-lesson roads by cooperation, as in the older and more thickly settled communities.

Thus far the only feasible method of aiding the people of such regions has been by the publications of the Office, by personal conference with local officials, and by addresses, illustrated, where possible, to general audiences. From several centers of population where agriculture is a prominent industry applications have recently come for aid in making such demonstrations. An attempt will be made to consider these with careful discrimination during the coming fiscal year.

In addition to his work for this Office, Mr. Abbott, entirely in his own time and at his own expense, in order to add to his knowledge and experience all phases of road-building science, made extended studies on the ground of the sand-clay and convict-built roads of the South, the macadam roads of New England, and the possibilities of using burnt gumbo in the western central region.

SPECIAL OBJECT-LESSON ROAD WORK NOT COVERED IN DIVISIONAL REPORTS.

The beneficial results of the object-lesson work carried on under the direction of this Office have been so pronounced in the sections where the roads were constructed and the demand for this kind of instruction has increased to such an extent from all parts of the coun-

try that the Office is at the present time directing especial attention to this feature of the work, four sets of men and machinery now being actively engaged in constructing object-lesson roads at as many different places. For the benefit of the many whom it is impossible to reach by the object-lesson method careful reports of the work have been made and are now being made showing the cost, method of construction, and other essential information, expressed in such a way as to be a guide for construction along similar lines. Object-lesson roads are built under the direction of this Office in cooperation with the local road officials on the following terms and conditions: This Office furnishes the expert knowledge and engineering skill to direct the work of construction and arranges with the Division of Tests of the Bureau of Chemistry of this Department for the testing of road-building materials. It also furnishes all machinery necessary to carry on the work, including the heavy earth-handling and rock-crushing machinery. The communities having the road built are required to furnish all materials, common labor, teams, fuel, etc., necessary to carry on and complete the work.

During the year Charles T. Harrison, special agent and road expert, was engaged in work in West Virginia, Arkansas, and Louisiana. In the first two States work had been started prior to the beginning of the present fiscal year, and the progress made on each was noted in the last report. A description of the work done follows:

Morgantown, W. Va.—The macadam portion of this road was constructed of limestone, shipped by rail from Deckers Creek and hauled by wagons to the road, one-half the distance being over exceedingly heavy grades. The stone was laid in two courses—a foundation course of 2½-inch size and a second course of 1½-inch size—the two courses being well bonded with limestone screenings, which also covered the surface. The machinery used was a 10-ton steam roller, 600-gallon sprinkler, a road grader, and a contractor's dump wagon, in addition to the wagons, plows, and wheeled scrapers furnished by the county. The width of the stone portion was 12 feet and the average depth 8 inches; length of macadam, 2,475 feet, of which 257 feet were placed in the various courses and left for travel to compact, to show the value of the use of a roller on such work. A portion of the work—about one-half mile in the village of Granville—was to be constructed of gravel taken from the bed of an adjacent stream. This work was undertaken by the local authorities and was under way when our force left for other work.

The stone and freight cost $1.30 per cubic yard, and hauling to road 50 cents, making cost of stone on road $1.85 per cubic yard. The cost of labor and teams was much higher than in other sections, and, because of the great amount of grading, as well as the necessity of having to do work over as a result of the excessive rains and other causes, the cost of the road was greatly increased, being about $7,000 per mile for macadam construction.

The severe weather of the past winter, the passage of heavily loaded narrow-tire wagons over the green road, dragging the sticky clay upon its surface, and the lack of suitable machinery and supervision to keep the road in shape, caused it to get out of repair much sooner than roads that are cared for after the first stage of construction. The fact that each end of the road was flanked by a heavy clay road, with another intersecting it about halfway, the clay when wet being pulled on the stone and dropping off on the surface and remaining there, worked to its detriment.

Batesville, Ark.—Toward the last of September Mr. Harrison went to Batesville, Ark., to construct an object-lesson road. The Butler Hill road, being an extension of Main street, leading out into the country, had been chosen for the lesson. It would have been difficult to find a road presenting more adverse conditions to overcome than this one. It was a new road extending along the side of a steep hill and through a thick woods in places. The local authorities were engaged in grading a single-track road and making rock fills when Mr. Harrison arrived. Pending the arrival of the machinery loaned for this work (a road

grader and 4½-ton reversible horse roller), the location of the road was changed to provide a more easy grade, the roadway was widened to 20 feet between gutters, hills were cut and fills made, and a number of substantial stone culverts put in. The machinery did not get to the work till October 29, and the work stopped November 20. The material used was a variety of cementing gravel from a small stream at the foot of the hill. This was laid in a single course and rolled to a compacted depth of 4 inches 12 feet wide. The gravel was hauled a distance of three-eighths of a mile, spread, and rolled in four days, at a cost of $80. The total amount of graded road was 2,600 feet; length of graveled portion, 1,700 feet. In the 2,600 feet were ten large culverts, four of which were placed within a space of 300 feet. A ditch was dug on the upper or hill side of the road, none being needed on the lower side because of the steep slope therefrom. The gravel was had for the hauling, the teams and labor being furnished by the county and worked under the direction of the supervisor, Capt. Y. M. Mack, who ably assisted in the work. The cost of all work done, including the preliminary grading, was $650. But for the near approach of winter the mile of road contemplated would have been completed. This thinly graveled road stood up well during the past severe winter and is expected to be finished during 1904. Much interest was manifested in the object lesson and more work is wanted from the Office in that section.

During his stay in Batesville Mr. Harrison addressed the Business Men's League, the Batesville Improvement Club (composed entirely of the progressive women of the town), the county quorum court, and the visiting supervisors on good roads day, November 19.

Fort Smith, Ark.—In my last report considerable mention was made of the good work done at Fort Smith in the spring of 1903 by Mr. Harrison, and carried on later by County Judge Falconer, with the result that requests for further aid from the Office was granted Sebastian County. Mr. Harrison arrived from Batesville on November 24, being joined the following day by his assistant, Road Expert E. W. Sheets, who had been with him on the Maryland and West Virginia work. Between that time and the start of the work the previous spring the county had fully equipped itself for modern work by the purchase of 25 road graders, a 450-gallon sprinkler, 10-ton steam roller, plows, slips, and wheeled scrapers. Several miles of road had been graded and covered with a foundation course of crushed and hand-broken stone, less than half being finished throughout. Chert, from Stillwell, Ind. T., along the line of the Kansas City Southern Railway, had been purchased ready for use.

Work began on December 2, 1903, and with but very few interruptions continued past the close of this fiscal year. There were several divisions of work done, the greater part being that of redressing foundation stone and covering with chert. The first work was 1,125 feet long and 18 feet wide. The next was nearly three-fourths of a mile on the Van Buren road, 12 feet in width. This took up the time to the holidays. Early in January 3,100 feet of North Sixth street was begun, starting from the end of a paved city street and extending to the city limits. This was a street composed of worn-out gravel, stones of various sizes, and clay. The old bed was spiked with the roller, harrowed, shaped with a grader, sprinkled and rolled to the required subgrade, 18 feet in width. Upon this the chert was spread and rolled to a uniform depth of 4 inches, the surface being covered with a thin layer of "chats," from the Joplin, Mo., zinc mines, and thoroughly rolled. After six months of steady and hard travel no appreciable wear can be noticed; neither has anything been done to keep the road in condition. This stretch is the connecting link between the Van Buren road and the city, and gives a straight-away drive of about 3 miles north of the city.

From the city limits on the south side, at Twenty-first street, the road leading out on B street to and on Little Rock avenue was resurfaced with chert, connecting with a stone macadam road ending at the cemetery and ball park. From the cemetery out over and around Pelleys Hill to the Suburban Railroad, a distance of about a mile and a quarter, a very superior section of work was done. Excepting a few hundred feet at the summit of the hill the work was strictly an object lesson, from the grading of the road to the final top surfacing. It represented a suburban drive 16 feet wide and a country road 12 feet wide. The roadway on the hill had a grade of 15 per cent and was very narrow. The grade was reduced to an average of 5 per cent by borrowing earth from an adjoining property and filling between the foot and top of the hill; this also widened the roadway. A large tile culvert extended under a heavy fill. During the grading of this hill Expert Sheets moved the county crushing plant to a rock

pile 2½ miles from the work, where stone for this road had been donated, and entirely reconstructed the plant, changing an old traction engine into a stationary one and designing and erecting a bin of 90 tons capacity, which is a model one. A smithy outfit was installed, whereby all tools were kept in order and much other repair work was done, at a considerable saving to the county.

The donated stone was a hard sandstone of good quality, suitable for light-traffic roads. This was crushed to suitable size and separated from the screenings. It was placed on a carefully prepared subgrade and compacted to 4 inches, being well bonded by the screenings, wet, and rolled. Upon this chert was placed and likewise compacted to 4 inches, giving an average depth of 8 inches to the finished roadway. In some places where there was a good natural foundation the depth of the chert and macadam was but 6 inches. A fine grade of shale rock was encountered in cutting one of the hills, and this was used as a binder in the place of screenings. It consolidated readily with the stone, showing that good roads for light traffic could be made of this combination when properly built and maintained.

As a result of the modern methods and machinery used and the acquired proficiency of the labor employed there has been a cheapening in the cost of materials, as the following will show: Former cost of crushed stone, delivered on road, per cubic yard, $1.35; cost on present work, $1. The price of chert has remained the same, viz, 85 cents per cubic yard, but the cost of hauling has been reduced. When first used 1 yard was considered a load and cost 60 cents; the present cost is 27½ cents per yard, 2 yards being hauled to the load.

The character of the work was so varied that it would be hard to give the exact cost of each section, but the average cost per mile of the work done was $3,500. Such work as that on Pelleys Hill, where extra grading was necessary, would cost about $5,000 per mile. So well satisfied are the citizens of that section that the cost of the roads under the plan of cooperation adopted does not act as a deterrent in any way, and the county judge has many applications for the extension of the work. B street, from the city limits at Twenty-first street and the beginning of the county chert roads, is now under construction. It will be 20 feet wide, of chert-covered stone, and will connect with the brick paving on Garrison avenue, giving the citizens, when it is finished, a driveway nearly 7 miles in length.

During the construction of the above work every detail of road building was taught those who would have charge of future work, so that with the complete outfit owned by the county the good work should continue, and is likely to so continue. The miles already constructed and those in contemplation have all been brought about through the cooperation of the Office of Public Road Inquiries and the county judge of Sebastian County, supported by interested citizens and good-roads advocates.

Mr. Harrison attended the annual meeting of the State Good Roads Association at Little Rock and the State Horticultural Society at Van Buren, making addresses at each. He also attended the National Good Roads Convention in St. Louis and visited Shreveport, La., to arrange for the building of an object-lesson road during the summer and to perfect arrangements for the giving of practical instruction to the students of the State university at Baton Rouge during the winter. In June he made a ten-days' tour of farmers' institutes in western Louisiana with one of the State institute corps, making addresses in the interest of better roads at many places.

The following is an outline of work done under the direction of D. G. Haire, road expert:

JOHNSON CITY, TENN.—The road upon which the object-lesson work was done is the main traveled highway between Johnson City, toward the new Federal soldiers' home, and Jonesboro. The object lesson was a mile in length. The old road was composed of red clay, very sticky when wet, but hard and firm when dry. On account of being poorly drained the road was often impassable during the winter of 1902–3. The old right of way was 40 feet wide, but this was increased to 60 feet. Fifteen culverts had to be provided, thirteen of which were for ordinary drains. Two culverts 40 feet long, 3 feet high, and 3½ feet wide were built of quarried stone. They were floored and capped with the same material and all joints were laid in cement. The other culverts were of vitrified sewer pipe and were all 40 feet in length. One was 30 inches in diameter, two were 18 inches in diameter, and ten were 12 inches in diameter.

The subgrade prepared to receive the stone was 16 feet wide and 9 inches deep

and had a crown of 6 inches, with a uniform slope from center to sides. Twelve thousand yards of earth had to be moved in order to secure proper drainage and suitable grades. One fill 6 feet in depth and about 200 feet in length was made. About 30 rods of the road had to be subdrained. This was done by means of a French drain 3 feet in depth, with laterals into side drains. These ditches were filled with 2½-inch crushed stone and thoroughly tamped by hand.

The machinery used consisted of an 8-ton steam roller, a 400-gallon sprinkler, a road machine, two spreading carts, and drag and wheeled scrapers. The stone was purchased already crushed. It was crushed in a jaw crusher and separated by means of a revolving screen. The screen was built in three sections, one section having 3-inch holes, one 2-inch, and one 1-inch. A dust jacket covered a part of the section having 1-inch holes so as to separate the dust from the three-fourths-inch stone, the dust being used for finishing and bonding.

The grading cost about 12 cents per cubic yard, or $1,440 for the entire length. The foundation course of 2½-inch stone was placed on loose 6 inches deep and was rolled to 5 inches, being bonded with limestone screenings. The second course of 1½-inch stone was placed on loose 5 inches deep and was rolled to 4 inches and bonded with limestone dust. After both courses had been placed in position and rolled the road was sprinkled and rolled until thoroughly bonded. The material was limestone of good quality, secured from the quarries at Watauga, Tenn. It was hauled 7 miles by rail and one-half mile by wagon. It cost 87½ cents per cubic yard delivered in Johnson City and about $1.25 per cubic yard laid down and rolled complete. The macadamizing, therefore, cost about $5,000 per mile, and adding the grading to this the road cost in all about $6,400. This cost is not excessive when we consider the fact that the macadam was 16 feet wide, the right of way 60 feet, and that good earth roads were built on both sides of the macadam. Ordinary country roads can be macadamized in East Tennessee for from $2,000 to $3,500 per mile.

The following is an outline of work on an object-lesson road under the direction of J. H. Dodge, road expert:

Beaver Dam, Va.—This road, located in Hanover County, is the main highway leading south from the Chesapeake and Ohio Railroad at Beaver Dam to the mountain road leading to Richmond, and extends from Beaver Dam to Terrells Store, a distance of 1½ miles. It was begun March 24 and finished August 10, 1904. The cross section was designed with gentle curves and comparatively shallow ditches. The cost of the earth work constituted a considerable item, as 2,000 feet of the road was constructed upon a new right of way that involved a cut and fill. The material used was a chlorite gneiss, being the refuse product of the sulphur mine at Mineral City, about 17 miles away, on the Chesapeake and Ohio Railroad, and the supply was superabundant. The macadam was placed in the center 10 feet wide, 6 inches deep at the center and 4 inches at the sides, rolled in place, with an earth shoulder to meet the macadam sloping gently to the ditch lines, which were 24 feet apart. Over this course of subgrade foundation stone, 2½-inch size, was placed No. 2 product from the crusher to a depth of 1½ inches, rolled in place and allowed to sift over the earth shoulder 1 foot on each side and finished to a feather edge. The voids were as completely filled as possible in each course of stone, supplementing the rock dust with a little clay over the first course, rolling first when dry and then when sprinkled. Finally the whole surface of the road was gone over and dressed up with a sufficient amount of rock dust to obtain a perfect finish, requiring about a half-inch coat, copiously sprinkled and rolled. The machinery used was a No. 4 crusher, a 3½-ton horse roller, a sprinkler, and automatic dump wagons. The cost of the road was $2,250 per mile.

BENEFICIAL RESULTS OF EXPERIMENTAL AND OBJECT-LESSON ROAD WORK.

It is noticeable that communities with good roads have a higher appreciation of the value of such roads than communities lacking them. It is also noticeable that wherever good-road building has been begun it has generally continued to spread over the adjacent area until limited by a lack of suitable local materials or of a sufficient

revenue to carry on the work. People who have once had the benefit of good roads are always in favor of extending the same to other communities, and people who have not been blest with these advantages seldom appreciate their value until they have been brought in contact in some way with such roads, or at least samples of them. Often people of the latter class will oppose all attempts to improve the highways because of their lack of appreciation of the advantages that will result therefrom, but they almost always change their minds when the improvement has been made in spite of their opposition. For this reason the object-lesson road possesses a value as a factor in the industrial and material upbuilding of rural communities far in excess of its intrinsic value as merely a sample of good road. Once the object-lesson road is established in a community with all the advantages of travel over its smooth and hard surface, the people are forced to a realization of the economy of good roads, and the result is generally an increased expenditure along that line. It is readily understood, however, that the number of people whom it is possible to reach directly by means of the object-lesson method is necessarily small. There are many parts of the country where good roads are never considered as within the range of possibility, because the people have a vague idea that the cost is utterly prohibitive; there are other sections of country where large sums of money are annually expended in ill-directed attempts at road building because of ignorance of the proper method of doing the work. Elsewhere in this report information showing the cost and the proper method of constructing hard roads is given in the form of detailed reports on the object-lesson roads actually constructed under the direction of this Office during the last year. It is important in estimating the cost of improved highways to take into consideration their durability as compared with common dirt roads. How the object-lesson roads built in previous years have withstood the strain of traffic and adverse weather conditions is shown in the following letters, which also indicate the marked effect which their construction has had in stimulating road improvement:

Geneva, N. Y., road.—Mr. S. D. Willard, Geneva, N. Y., August 17, 1904, writes concerning the present condition of the road built at that place in 1898 and what has been done as a result of its construction:

I was one of the committee appointed by this city in charge of the "object-lesson" road built here in 1898, in the construction of which we had the cooperation of your Office, and I can briefly give you the results as I have watched them.

That portion of the road that was built of Hudson River trap rock and wet down and rolled thoroughly is in splendid condition to-day. No such piece of road has ever been seen in this county. But before getting the road completed we were obliged to use soft stone, which was uneven in texture, and the portion of the road on which it was used has not stood as well as the other. However, as an object lesson the road has been very valuable to this city and county, and I am sure that were the same course pursued in other sections of the State the result would be as good. Under our State law, last season 5 miles of road were built in the same manner, except that limestone was used instead of trap rock. The people are delighted with this road, but, as you can understand, it will not be as durable as the trap-rock road. I might add that one of the best streets in Geneva, the cue being taken from the first section of road referred to, has been rebuilt a little over a mile in length, and is one of the best roadbeds that can be found in the country.

ITHACA, N. Y., ROAD.—Mr. Frank J. Enz, Ithaca, N. Y., August 26, 1904, writes as follows:

The road built in this county under the direction of the Government road experts in 1898 is really the only good road leading out of our city. I have traveled over it a number of times, and it is a real pleasure to drive over such a road. Its present condition is excellent, and its effect on road building is good. The writer has traveled a number of times through Germany, his native country, also through Austria and France, both by wagon and on foot, and must say that the road built in this county from Ithaca toward Brookton excels even the macadam road of those countries. Strong efforts are put forth by the farmers of this county to avail themselves of the assistance which our State is offering them in the building of good roads. Let the good work go on, and give us such assistance as you can, and I am sure I express the sentiment of the public when I say they will call you blessed.

BRADSHAW, MD., ROAD.—Mr. John Arthur, Fork, Md., under date of August 15, 1904, writes as follows in reference to the road built at Bradshaw, Md.:

The sample road that Mr. Harrison built in 1898 is standing well, although it gets very little attention. I am sure that it has not been touched this year, not even having the gutters cleaned out. The road seems to be smoother now than it was two or three years ago. It seems to have no loose stone on it, whereas it used to have a great many. I can not account for this, unless it is due to the two wet seasons that we have had. I do not think there has been a great deal of heavy hauling over the road for the last year or so, but when one considers the travel on it and the little attention given it since it was constructed it must have been very solidly built.

HOT SPRINGS, VA., ROAD.—The following, from C. W. Richardson, chief engineer Virginia Hot Springs Company, under date of August 19, 1904, refers to the road built at that place under the direction of this Office:

Your Department supervised the construction of one-half mile of macadam road for us during the summer of 1899. The road was carefully graded, then filled 4 inches with firsts from the rock crusher, none larger than would pass through a 3-inch ring; this was dusted with screenings and washed in with sprinkler and rolled hard with a 15-ton roller. Then a second course was put on of seconds, none larger than would pass through a 1½-inch ring; this was then treated in the same way as the first course, and, finally, one-half inch pure screening was used for a finishing course, and all rolled to a smooth and compact surface. The material was limestone. It cost $3,800 per mile for road 8 inches thick and 16 feet wide.

J. T. McAllister, Hot Springs, Va., writes in reference to this road, under date of August 24, 1904, as follows:

As to the effect the building of this object-lesson road has had in the stimulating of road improvement in this section of the country, it seems to me that the effect has been quite marked. The Hot Springs Company constructed nearly 4 miles of macadam in the direction of the Healing Springs, and Mr. Jacob Rubino, the owner of the Rubino Healing Springs, took the matter up at that point and extended this road through his property.

The roads in this section, and particularly in this and the adjoining valley, are kept up to the highest degree of efficiency, and are being worked with good road machines. In fact, for nearly 23 miles of this road the county has made liberal appropriations and has turned this amount of road over to the Virginia Hot Springs Company under a five years' contract, and it is expending annually the sum of $1,500 in raising the standards and getting these roads in good physical condition.

KNOXVILLE, TENN., ROAD.—Mr. John R. Fain, assistant agriculturist, agricultural experiment station, Knoxville, August 18, 1904, writes as follows:

The object-lesson road built under the direction of the U. S. Department of Agriculture is still in exceptionally good condition, and has required very little

work on it to date. While as a rule there has not been a great deal of heavy hauling over it, just after the road was put down it was used for some months in dry weather for heavy hauling. Most of the loads that were hauled over it were brick. This was rather hard on the road, in view of the exceedingly dry weather at that time, but it stood the strain remarkably well.

Road building in Knox County has increased very much the last two years, but taking East Tennessee as a whole the question of good roads is receiving more and more attention. As we have a representative gathering of the best farmers of this section each year at the experiment station, it is hard to say just how much good this object-lesson road has done.

DOYLESTOWN, PA., ROAD.—The following letter, dated August 29, 1904, was received from Histand Brothers, Doylestown, Pa.:

The road constructed here in 1900 as a sample under the direction of Government road experts is one of the leading roads to Doylestown, and has a great amount of traffic which does not seem to affect it in any way. The cost of repairs has been very trifling. The weather seems to have no effect on it. Everyone speaks well of it, and a continuance of this road would be very much appreciated by the community.

TRAVERSE CITY, MICH., ROAD.—Hon. Frank Hamilton, Traverse City, Mich., under date of August 16, 1904, writes as follows in regard to the object-lesson road built at that place:

The object-lesson road constructed in 1901, under the direction of the Department of Agriculture, adjacent to our city, has stood the wear and is now in excellent condition, and we believe will be for years to come.

Both the direct and indirect benefits are very apparent. The adjoining townships in many instances have profited by this improvement and have contributed from time to time very materially in the amount of their road building and in the amount of their improvement. The work was an entering wedge in this section, and it is hoped the time will soon come when the States will more heartily approve of some appropriation for our road work.

FLORENCE, ALA., ROAD.—Mr. J. E. F. Westmoreland, apportioner, Florence, Ala., in his letter of August 6, 1904, says:

The model road built under the direction of M. O. Eldridge, of the U. S. Department of Agriculture, in 1901, is 130 yards long and cost $65. After the foundation was put in shape one layer of creek gravel was put on, then one layer of chert 6 inches in center and tapering to edges. The road is in fine condition and has withstood all kinds of traffic and all weather conditions. The road beyond the model section has been made a magnificent pike. No doubt the building of these model roads is a great stimulus for better roads.

Mr. J. H. Dodge, Government road expert, makes the following reports on the present condition of the object-lesson roads built in the State of Ohio under the direction of this Office:

LEROY ROAD. Westfield Township, Medina County, Ohio, cost $2,480 per mile. This road, running west from Leroy toward Lodi, was built in the month of June, 1902. It has withstood the agencies of destruction to which roads are subjected remarkably well, and after two years' use it is in better condition than at any time since it was built, having improved under traffic. The surface is perfectly smooth and hard, free from ruts, dust, or mud, and in every way a good road in the highest sense. Nothing has been done in the way of repairs.

DOVER ROAD, Dover Township, Cuyahoga County, Ohio, cost $2,870 per mile. It was built during the months of September and October, 1902, and is one of the most important in the county. It is subjected to almost continuous traffic, both heavy and light. This road, like the one at Leroy, has become solid pavement. Nothing has been done to repair the road. It is considered a great success and was extended last year three-fourths of a mile.

KIRTLAND ROAD.—This road, in Lake County, Ohio, cost $1,728 per mile. It was built in the month of May, 1903. The only difference between this and the Leroy road is to be found in a few loose No. 1 stones appearing upon the sur-

face by reason of the fact that the granite used was a little too hard for the traffic and binds slowly. It finally becomes a solid pavement, however, resisting erosive action remarkably well, as is shown in the older roads built of the same kind of material. No repairs whatever have been made upon this road.

RUSSELL ROAD.—This road, in Geauga County, Ohio, cost $3,310 per mile. It was built June 3 to August 3, 1903. No repairs have been needed.

CHAGRIN FALLS ROAD.—This road, in Cuyahoga County, Ohio, was built in August, 1903. No repairs have been made.

BAINBRIDGE ROAD.—This road is also in Geauga County, Ohio. It was built in the months of August and September, 1903, and has received no repairs.

The last three of these roads, built after the same plan, with 9 feet macadam on one side and 8 feet dirt on the other, using the same kind of material—sandstone base and granite bowlder surface—look and behave very much alike, although the heavy and continued rains of spring and summer have disturbed the earthwork and changed the ditch line to some extent. These roads are a success and are believed to give the fullest measure of satisfaction to the people.

Dr. J. E. Phelps, Chagrin Falls, Ohio, writes under date of July 16, 1904, as follows concerning the road at that place:

I wish to express the appreciation and general satisfaction felt in this community regarding the great benefits resulting from the construction of the object-lesson macadam road in this township one year ago, under the supervision of J. H. Dodge, Government road expert. The perfect condition, during the past winter and spring, of the one-half mile of macadam road in this township, together with an adjoining mile of the same constructed in Russell Township, is a convincing argument that expenditure of money in constructing improved roads is a profitable and wise investment for any community. I believe that the building of improved roads will constitute a new era in the progress of our country.

Mr. Clinton Eggleston, president Russell Farmers' Club, of Chagrin Falls, Ohio, writes under date of July 18, 1904:

The macadam roads in this township, the mile in Russell and the part of a mile in Bainbridge, built last summer under the supervision of Government Expert J. H. Dodge, seem to be in better condition now than when completed. They are more compact, well bonded, and just as smooth, except for a very slight wheel track resulting from everybody keeping to the same track instead of spreading out the traffic over the whole road surface. This condition is in greater part due to the almost exclusive use of narrow-tired vehicles, and, I think, would be avoided by the use of wide tires. The dirt road running beside the macadam is used by very few persons, even when in the best condition.

During the past winter and spring many persons have gone considerably out of their way to get the benefit of the improved roads, the common country roads being nearly impassable for several weeks. These short sections of road seem to have made a great impression upon the people of this vicinity, and it is generally conceded that the expenditure of money in building improved roads is to be commended from an economic standpoint, enhancing greatly the value of lands and the opportunities of life in the country, and eventually effecting a great saving in public money.

F. C. Gates, secretary of the Cuyahoga County Agricultural Society, and Frank P. Shumaker, mayor of Chagrin Falls, have written letters expressing views similar to the foregoing.

J. H. Freeman, of Leroy, Ohio, July 16, 1904, writes the following:

I beg to say that the piece of road at Leroy is giving universal satisfaction. Even those who criticised the work when it was being done and were of the opinion that it would not pack and cement as the limestone roads do have now, after two years' use—two years hard winter trial—nothing to say; and I would say that we believe it is a road that is good for at least one generation, if not more.

FROSTBURG, MD., ROAD.—The following, from Mr. G. G. Townsend, road engineer, Frostburg, Md., under date of August 11, 1904, shows conclusively the good effects of the work done in that county:

The building of the object-lesson road between Cumberland and Frostburg in 1902, under the supervision of the Office of Public Road Inquiries, has had a most decided effect in stimulating a desire for more roads of the same kind in this county. In proof I may cite the fact that our board of road directors have just asked for the full amount of Allegany County's allotment for State aid, amounting to $8,967.39, to be supplemented by an equal sum from the county, and used next summer in building four pieces of permanent road on as many of the main thoroughfares of the county. Thanks to the object-lesson road built by the United States Department of Agriculture, we have a crushing plant equipped with screen and bins, a 10-ton steam roller, etc.; and better than all, a public demand for substantial road work such as you gave us, with four more pieces distributed throughout the county. I am convinced that the good influence will be felt, that the future demand for good roads will become stronger and stronger, and that Allegany County will soon be on a higher plane and demand better things of her road builders than she has in the past. There is also a growing sentiment in favor of wide tires which is very encouraging. It will never be possible to have all of our roads built substantially of stone, but I believe it would be possible to have all roads good roads if we could regulate the width of the tires to suit the loads to be carried by them at a lower cost than now paid for building roads to be cut to pieces by the narrow-tired wheel under a heavy load.

The road built by the Government road experts on Red Hill on the National road is standing splendidly. Notwithstanding the heavy grade and the tremendous rains we have had this summer and last, the only effect is a slight guttering along the line between the macadam and the dirt shoulder. We are going to run the road machine over the earth shoulder and smooth it up and then roll it heavily, and that will make it about as good as new.

Mr. J. A. Summers, of Johnson City, Tenn., writes August 30, 1904, concerning the road built at that place:

This is one of the best pieces of road ever constructed in Tennessee, having been carefully built under the direction of your experts, and after more than a year's use, with unusual rains prevailing, the road shows no sign of wear, but is seemingly in as good condition as when completed.

The community at large is greatly pleased with this road, and it has done much good toward creating a public sentiment in favor of good roads.

PROGRESS IN ROAD LEGISLATION IN THE DIFFERENT STATES.

A brief review of the progress of road legislation and road improvement in the various States has been prepared, care being taken to mention only such legislation as can safely be considered an advance over the statute labor system, or modifications of that system, prevailing in most of the States, but which is gradually but surely being superseded by some form of State aid or cooperation which seeks to apportion the burden of cost in a more equitable manner, to provide a greater revenue, and to secure better results than were possible under the old system.

In some States counties are authorized to issue bonds in order to obtain money for road improvement. Many of the States are using convict labor in working the public roads, this being more general in the South than in other sections of the country.

In the following paragraphs a brief synopsis is given of the road laws in force at this time in the States designated, together with a short statement of the progress of the work under such legislation:

ALABAMA.—The recent legislature passed a general law permitting counties to vote at any time for a bond issue or a special levy for roads.

CALIFORNIA.—The legislature of 1895 created the State bureau of highways, with three commissioners, appointed by the governor, to hold office two years, and appropriated $83,500 for carrying on State road work; in 1897, by legislative enactment, the bureau of highways was superseded by the State department of highways, with three commissioners to hold office for two years, they to be succeeded by one commissioner, appointed by the governor, for a term of four years and every four years thereafter. In 1897 the legislative appropriations for State road work aggregated $44,900; in 1899, $74,500; in 1901, $23,060; in 1903, $58,360. California has no State-aid road law. Most of the roads are constructed under the direction of the boards of supervisors of the counties, by direct taxation for that purpose. The roads constructed and maintained by the State are in mountainous regions where the population is sparse and where direct communication between more productive sections is desirable.

CONNECTICUT.—In the State of Connecticut the legislature has appropriated for the building of State roads, from 1895 to 1902, the sum of $1,233,000, and during the same period the counties have appropriated for State road work $810,942.55. In the building of State roads the State pays two-thirds of the cost in towns having a taxable valuation of over $1,000,000, and three-fourths in towns having taxable valuation less than $1,000,000, the towns paying the balance of the cost. The towns are required to repair State roads, but if they fail to do so the State repairs them and charges the amount to the towns. About 450 miles of road have been built since 1895 under the State-aid plan, at an average cost of about $3,600 per mile for gravel and $6,500 for 16-foot macadam. This cost includes grading and culverts. The last legislature increased the appropriation to $225,000 for 1903–4. Connecticut has 15,000 miles of roads, and it is estimated that 5,000 miles will ultimately be improved under the State-aid plan.

DELAWARE.—The legislature of Delaware in April, 1903, passed a State-aid bill which provides for the appointment of three highway commissioners to have charge of the State road work—one in each county. It further provides that the expense of constructing State roads shall be borne equally by the State and the county interested, and $30,000 per year for the following two years was appropriated as the State's share of the expense for road improvement. Ten miles of macadam road have been built in Newcastle County and 3 miles in Sussex County. Kent County thus far has failed to take advantage of the State-aid law. These roads have been much admired and favorably commented upon by all the people of the State who have used them or seen them, and they bear the strongest testimony to the wisdom of the last legislature in enacting the present law. The roads in Kent County have been built of Brandywine granite and Birdsboro trap rock, at a cost of about $6,000 per mile. The roads are built of macadam, 16 feet wide and 8 inches deep, with shoulders on either side extending to the full width of the roadbed, making a permanent highway about 35 to 40 feet in width. In Sussex County, where about 3 miles of macadam road have been built at about the same cost per mile, the roads have proven to be equally satisfactory, and the people are already beginning to clamor for more roads. In the beginning the strongest opponents to this law were the farmers, but since they have seen the advantages of these roads, especially to themselves, many of the most intelligent farmers have become the strongest advocates of the principles of the road building as embodied in the State-aid law, and it is expected that the next legislature, which convenes in January, 1905, will pass a few minor amendments to the law—amendments the need of which has become apparent in two years' operation of this law—and it is also expected that an appropriation will be made by the State of sufficient proportions to build many miles of the most important roads in all three of the counties during the next two years.

FLORIDA.—A recent act of the legislature sets aside for the improvement of roads the proceeds of the Indian war claims, the payment of which has been authorized by Congress. From this the State will realize over half a million dollars. Another act, adopted June, 1903, provides that all moneys now in the internal-improvement fund, or which may be derived from the sale of State swamp or overflowed lands, shall be devoted to the construction of hard roads, being divided among the several counties in proportion to their assessed valuation. Under act of the legislature approved June 3, 1899, all persons confined in county jails for a term of one year or less shall be worked on the public roads.

ILLINOIS.—The legislature of Illinois at its last session enacted a law providing for the appointment of a good-roads commission, consisting of three persons,

one of whom shall be a civil engineer familiar with the problems of highway construction, another to be one who has had experience as a commissioner of highways in the State of Illinois, and the third to be a business man of high standing.

In compliance with the terms of the law, Governor Yates appointed H. U. Wallace, of Chicago, chief of the engineering department of the Illinois Central Railroad; Robert D. Clarke, a prominent business man of Peoria, and D. W. Smith, of Springfield.

The commission is now engaged in the work laid out for it by the legislature. Among other things, it is making a survey of the present wagon roads of the State. It is also endeavoring, with good prospect of success, to secure from the railroads of the State very low rates of transportation on material to be used in the construction of wagon roads. It has also taken up with the authorities of the northern and southern Illinois penitentiaries the question of securing an abundant supply of crushed stone, to be distributed by rail to the various sections of the State.

There is observable already a gratifying change in public sentiment throughout Illinois upon the subject of improved roads. Many local good-roads associations are being formed, and the people in many localities are now actively engaged in building good roads at local expense. The investigations so far conducted by the Illinois good-roads commission indicate that the cost and difficulties of the construction of good roads in Illinois have been very largely overestimated and that when these questions come to be properly understood by the people the roads of Illinois will in a very few years compare favorably with those of any State in the Union.

Iowa.—An act approved April 13, 1904, was adopted by the general assembly providing for the appointment of a State highway commission. The Iowa State College, at Ames, is to act as such commission. The duties of the commission shall be to devise and adopt plans and systems of highway construction and maintenance, disseminate practical information on road construction, and assist in building object-lesson roads.

Maine.—Legislation was enacted in 1901 providing that any city or town may receive from the State treasury one-half the sum actually appropriated for a State road within the corporate limits of such city or town; but the sum to be received from the State shall in no case exceed $200. Nearly all the towns appropriated this year $400, thus becoming able to draw from the treasury the maximum amount. As an experiment, the State at first made the maximum amount $100, but after a trial of the law for two years the legislature increased the maximum.

Maryland.—The Maryland highway division of the State geological survey was established by the general assembly in 1898 for the purpose of investigating the conditions of the roads in the State and the best methods of improving the same. Since 1898 $10,000 has been appropriated each year for carrying on the work of this division. A most careful and searching inquiry into the road question of the State has been made and several exhaustive reports issued. The highway division reports, among other things, that there are 16,000 miles of roads in the State, of which 497 miles are toll roads. There are about 900 miles of stone, shell, and gravel roads maintained by the counties. It is estimated that the counties spend for road maintenance $600,000 annually and that the people of the State pay about $140,000 annually in tolls. It is estimated that the average hauling distance is 6.7 miles and that the average amount hauled in tons per horse is 0.58 ton. The average cost of hauling 1 ton per mile in Maryland is 26 cents. The cost of properly built macadam roads in Maryland, graded for a width of 20 feet with macadam 12 feet wide, varies from $4,000 to $6,000 per mile.

The general assembly of 1904 passed an act which provides State aid for the construction of modern macadam roads to the extent of $200,000 annually, one-half the cost of the roads constructed under the law to be paid by the State. The amount received by each county is the direct proportion the public-road mileage of the county bears to the total public-road mileage of the State.

Massachusetts.—Massachusetts appropriates annually $400,000 as State aid. The State pays the entire cost of the road, but 25 per cent of the cost is assessed on the counties. The State has appropriated for the building of roads an aggregate of $4,940,000. The Massachusetts highway commission, which was established in 1894, has received some contributions from counties, towns, and

individuals to assist in building roads, which amount to $210,923, making a sum total of $5,150,923. The recent legislature appropriated $2,250,000 to be expended for State highways during the next five years. The average cost per mile of 12 to 15 foot stone roads in Massachusetts in 1904 is $6,200, the depth varying from 3 to 12 inches. Gravel roads 15 feet wide and 6 to 8 inches deep cost from $3,000 to $4,000 per mile. Five hundred and four miles were built or under contract up to January 1, 1904. It is estimated by the Massachusetts highway commission that there are 20,000 miles of roads in the State and that 1,900 miles will ultimately be improved by State aid.

Michigan.—Every township has the right to raise money by bonding to the extent of 5 per cent of its valuation to build gravel, stone, or any other kind of roads or to construct bridges. Any county may adopt the county road law and assess a 2-mill tax each year to build good roads. County commissioners are elected, who hold office twice the number of years that there are commissioners elected, which can not be more than five, usually three. The State highway department act provides that every road or street official in the State shall make annual reports to the State highway department, and every such official has the right to seek from said department information about material or how best to build roads or bridges.

Nebraska.—The legislature of Nebraska recently passed a bill providing for cooperation with the Federal Government whenever National aid to road construction shall be undertaken.

New Hampshire.—The legislature of New Hampshire passed a bill providing for the appointment of a State engineer, who shall prepare a highway map of the State and plan a system of continuous main highways which shall include every town in the State, $15,000 being appropriated for the purpose. It also provided in the bill that the governor and council shall prepare for the next general assembly a bill which will provide fully for the inauguration of a system of State work and of State expenditure in the future construction and repair of highways. The next general assembly meets in January, 1905.

New Jersey.—The State-aid law of New Jersey was adopted in 1891 and became operative in 1892. In 1895 a new and more comprehensive law was enacted, under which one-third of the expense of building the State roads was borne by the State, 10 per cent by the individuals along the line of the road to be improved, and the balance by the county in which the road was located. In 1903 a new law was enacted. This law permits an increase of the State appropriation to $400,000 and gives the counties the right to assess upon their ratables for road purposes to the extent of one-half of 1 per cent, exclusive of the State appropriation. It allows the townships to pay 10 per cent of the cost instead of the property holders along the line. Under the law of 1895, 900 miles of roads have been built. Under the new law of 1903, 65 miles have been built and several hundred miles projected. The total number of miles built by the State up to July 1, 1904, was 1,100, at a cost to the State of $1,515,168.55, and at a cost to the State, counties, and townships of $4,930,000. The State appropriates $250,000 per annum as State aid. The average cost of macadam roads in 1904 is $7,000 per mile. The average width is 14 feet and the average depth 6 inches. The average cost in 1903 was $6,000, when labor and materials were cheaper. The average cost in 1904 of gravel roads 7 inches thick and 14 feet wide is $2,000 per mile. There are 20,000 miles of roads in the State, and it is estimated that one-half will have to be improved.

New York.—The State-aid laws of New York approved March 24, 1898, and which have been amended in many instances, are:

(1) The Higbie-Armstrong act, which was enacted for the purpose of permanently improving the main traveled roads of the State leading to or connecting the principal centers of population and known as first-class roads. This law provides that the State shall pay 50 per cent, the counties 35 per cent, and the towns or abutting property owners 15 per cent of the cost of construction in accordance with plans and specifications prepared by the State engineer and surveyor.

(2) The Fuller-Plank act, which provides State aid to the towns which by vote have adopted the money system for the improvement, repair, and maintenance of the public highways known as second-class roads, or those acting as feeders to the main traveled roads. Under this law the State aid is 50 per cent of the amount levied in each town, which amount is limited to one-tenth of 1 per cent of the assessed valuation of the towns, excepting those which have assessed valuation of less than $1,000,000.

There are 74,097 miles of public highways in the State of New York. Up to July 1, 1904, nearly 700 miles of road were constructed or in process of construction in accordance with the provisions of the Higbie-Armstrong act. There are 30,893 miles in various towns of the counties of the State which have adopted the money system.

Under the Higbie-Armstrong act the appropriations by the State and counties for the years 1899 to 1904, inclusive, were $8,662,694.15.

Under the Fuller-Plank act the appropriations by the State and towns for the years 1899 to 1904, inclusive, were $3,045,573.09, making a grand total of $11,707,667.24 appropriated by the State, the counties, and the towns for the improvement, repair, and maintenance of public highways within the State.

The total amount of money available from State and counties for the year 1904 for the construction of roads under the Higbie-Armstrong act is $2,213,014.30.

The total amount of money available from State, counties, and towns for the year 1904 for the improvement, repair, and maintenance of public highways in the State under the Fuller-Plank act is $1,311,365.89. The total amount of money available under both laws for the year 1904 is $3,524,480.19.

Under the Higbie-Armstrong act there are now on file in the office of the State engineer and surveyor petitions from the various counties of the State for nearly 4,500 miles of road.

The legislature of the State has once passed a constitutional amendment which provides that the State may bond itself for $50,000,000, $5,000,000 of which is to be available each year for ten years, for the improvement of the public roads. This amendment must be passed by the next legislature and then submitted to the popular vote before it becomes effective.

The average cost of macadam roads in 1901 was $7,950 per mile; in 1902, $8,819 per mile, and in 1903, $8,063 per mile. The usual width of such highways is from 12 to 16 feet and the usual thickness 6 inches after rolling. The average cost of 32 miles of gravel roads in Orange County was $2,146 per mile, the usual width 12 to 16 feet, and the average depth 6 inches after rolling. All grading, small bridges, culverts, etc., are included in the cost.

North Carolina.—North Carolina has a highway commission, established three years ago. The commission is composed of the State commissioner of agriculture, the State geologist, and the State secretary of agriculture. Its duty is to collect and disseminate information and to report to the legislature.

New Mexico.—In 1893 the legislature appropriated $5,000 to pay for tools and other additional expenses which would be incurred in the use of convict labor upon the construction of a road between Santa Fe and Las Vegas, N. Mex. This road will run through some very rough mountain country throughout almost its entire length. There is available about 9 miles of good road at the Santa Fe end, and since the spring of 1903 work has been pushed in an endeavor to extend the road already available across the remaining distance, a total of about 40 miles. There has been completed on the Santa Fe end about 6 miles of this new road and on the Las Vegas end about 4 miles of the new road. All of the work has been done in a very substantial manner, and well-informed persons state that the road which is being constructed on the Las Vegas end has no superior in any mountain road in the country.

Ohio.—The last general assembly enacted legislation providing for a State highway department for the purpose of instructing, assisting, and cooperating in the building and improvement of public roads, making investigations and experiments in best methods of road building, best materials, etc., and publishing literature on the subject of road improvement. It also provided for State aid in the construction and improvement of roads under the provisions of the act mentioned as follows: One-fourth to be paid by the State and three-fourths to be a county charge, but one-third of said three-fourths to be paid by the township. In apportioning the 25 per cent to be paid by the township 10 per cent shall be a charge upon the whole township and 15 per cent a charge upon the abutting property.

Pennsylvania.—The legislature of 1903 adopted a State-aid law, which was approved April 15, 1903, creating a State highway department under the direction of a State highway commissioner, and providing that two-thirds of the cost of rebuilding roads is to be borne by the State, one-sixth by the county, and one-sixth by the township. A total appropriation of $6,500,000 was made, distributed as follows: Five hundred thousand dollars for each of the first two

years, $1,250,000 for each of the next two years, and $1,500,000 for each of the next two years. Of the foregoing amounts, one-tenth is for the maintenance of improved roads, constructed under the law of 1903, or roads previously built which conform to the State standard. Such aid in maintenance must not exceed one-half of the total expense. That part of the appropriation used for construction purposes is apportioned among the several counties in proportion to their mileage of public roads. About 125 petitions for State aid were on file July 1, 1904, and over 40 miles of road were under construction or in course of preparation for construction.

RHODE ISLAND.—The last legislature passed a resolution appropriating $100,000 for the construction and maintenance of highways under the direction of the State board of public roads, which was created by the preceding legislature. Out of 2,240 miles of highway in Rhode Island about 500 miles have been improved by the use of gravel and stone.

SOUTH CAROLINA.—In South Carolina an act was passed authorizing the county commissioners of any county to hold elections to decide upon bonding the county for the permanent improvement of the highways to an amount not to exceed $200,000, or 8 per cent of the assessed valuation of that county, the fund so raised to be expended under the direction of said commissioners. Another act was passed permitting counties to work convicts with ten-year sentences in chain gang. Hitherto the counties have not been permitted to work convicts whose terms of sentence exceeded five years.

VERMONT.—The Vermont plan for State aid for highway improvement assesses annually a State tax of 5 mills on the dollar, to which is added the revenues from the local-option license law. The fund for the year 1904 is $130,811.37. This is apportioned to all the towns in the State, proportional to mileage of roads in each town.

The State commissioner furnishes specifications for work involving the expenditure of moneys appropriated by the State, and has supervision of the work, which must be done to his satisfaction by the town road commissioners before payment is made to towns. The specifications provide for drainage, telford foundation wherever artificial foundation is needed, surfacing with good road material, and properly finishing the road. All culverts to be substantially built of stone or vitrified tile.

The work is laid out in rebuilding in permanent form the poorest sections of the main roads, and the location is selected each year by the selectmen and road commissioner of the towns.

In 1903, 93 miles of road were built, 28 miles of which had telford foundation; also 1,068 culverts.

For maintenance towns annually assess a money tax of 20 per cent on a grand list (basis 1 per cent of valuation). A small portion of this is merged with the State aid and expended under the same regulations.

PLANS FOR 1904–5.

Heretofore the operations of this Office in the line of object-lesson road work have been seriously handicapped because of a lack of funds, but with the moderate increase allowed in the appropriation for the ensuing year it is expected that much will be accomplished in that direction; in fact, the entire field force of the Office, together with several temporary employees, is at present engaged actively in practical experimental and object-lesson work, while plans now being formulated contemplate the continuance of the work during the entire year, the work being so arranged that the men will gradually move south as the cold weather approaches, working north again as soon as weather conditions will permit. Work is already in progress at Chagrin Falls, Ohio; Dekalb, Ill.; Shreveport, La., and Bellingham, Wash., and arrangements have been perfected for cooperating in the construction of object-lesson roads near Coshocton and Columbus, Ohio; Springfield, Lebanon, and Neosho, Mo.; Pittsburg, Kans.; Beaumont, Tex., and Walla Walla, Wash. Applications are on file

from many places in the Southwestern and Southern States, at which work will be carried on during the winter, and from places in the Northern States, where work will be carried on during the following spring. The cooperation extended by this Office is in all cases preceded by a formal application from those having jurisdiction of the road sought to be improved, setting forth their willingness to comply with the terms and conditions under which the assistance is granted. The ever-increasing demand from all parts of the Union for instruction by the object-lesson method demonstrates the fact that the people are eager for good roads and want to be started right.

It is also intended that the information obtained through the construction of object-lesson roads shall be disseminated as widely as possible, and to this end a careful and comprehensive record will be kept of each road built, giving cost, method of construction, and other essential information, in such form as to serve as a guide for others who desire to construct roads under similar conditions, and it is intended that these records will be issued in a publication of this Office.

The experimental work for the purpose of determining the best and most available road-building material in the various sections of the country will be pushed vigorously, and from present indications it is hoped that most promising results will be obtained in this direction. Experiments will shortly begin in the use of burnt clay and gumbo in road building, while scientific investigations and experiments are being carried on relative to the use of sand clay, mineral oil, bituminous macadam, and other materials.

It is hoped that arrangements may be perfected whereby instruction and advice may be given in the form of lectures delivered by men qualified by careful training and natural ability for this kind of work without detaching the road experts to any great extent from the field work.

Several new publications will probably be issued during the year, and the information obtained by means of investigation, experiment, and object-lesson work will be duly transmitted to the public through this medium.

RECOMMENDATIONS AND ESTIMATES FOR 1905-6.

The reports of Government cooperation in object-lesson road building quoted in this report seem to prove not only the statement made at the outset, that a good road makes converts to permanent highway improvement, but also that a section of good road built as an object lesson under the direction of the United States Government in any community has the effect of awakening much greater interest than such a road constructed by the local authorities. That the people desire instruction by the building of object-lesson roads and are willing to bear the expense incident thereto is fully proved by the requests received for cooperation, the number being far more than we are able to comply with. That the results are almost uniformly satisfactory and frequently beyond the most sanguine expectation is demonstrated by reference to the letters embodied in this report from representative citizens in the sections where the roads were built and by personal investigations by representatives of this Office. In some instances the object lesson resulted in the slow but steady improvement of the

common roads; in a few cases the results were the inauguration of extensive systems of road building. In practically every instance some measure of progress resulted from the object lesson. It would seem to be conservative to estimate that an average of at least 10 miles of improved highways are constructed as a result of the building of each of these roads. The expenditure by the Federal Government for supervision, transportation, and other expenses incident thereto rarely exceeds $500 for each object-lesson road. Estimating the 10 miles of roads at $3,000 per mile, it would appear, if the assumption is correct, that for every $500 expended by the Federal Government for supervision, $30,000 is expended by local governments in the construction of splendid highways. The advisability of carrying on this work on an extensive scale by liberal appropriations can not be doubted.

In the object-lesson and experimental road work of the Office we endeavor to study all local conditions, such as climate, soil, rainfall, drainage, and materials adjacent to the road. We also locate and secure tests of all available materials, and show how to use them to the best advantage in order to build good roads for the least expenditure of money and labor. It is also necessary to demonstrate the use and value of the modern road-building machines, such as the crusher, elevator, screens, and bins, the spreading carts to carry the material from the bins to the road without rehandling, and the steam roller to consolidate the materials. Heretofore the Department has depended upon the road-machine companies to supply these machines for object-lesson and experimental road work. During the present season, however, this Office has had considerable difficulty in securing sufficient machinery. The manufacturers have not been able to fill their regular orders, owing to the extraordinary increase in the demand for road machinery, and have, therefore, not found it possible to fully supply the Department. Much annoyance and delay have been caused by this state of affairs, and I therefore urgently recommend that substantial provsion be made in the appropriation for the next fiscal year for the purchase of machinery and apparatus for use in experimental and object-lesson road work.

The experimental work of the Office is continually broadening in its scope and with a liberal appropriation it is believed that most gratifying results could be obtained.

In view of the foregoing, I most earnestly recommend that the appropriation for this Office for the fiscal year 1905–6 be increased from $35,000 to $75,000.

The work of this Office appears to be no longer of tentative character. Year after year it has assumed increased importance and wider scope, and there is now a general demand coming up from all sections of the country that it be made a permanent feature of the work of this Department. It appears fitting, therefore, that it be given a more definite legal status, thereby adding dignity and stability to this branch of the Department's work. I therefore respectfully recommend that the Office of Public Road Inquiries be transformed into the Division of Public Roads, with a statutory roll of officers and employees.

REPORT OF THE DIRECTOR OF THE OFFICE OF EXPERIMENT STATIONS.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., September 24, 1904.

Sir: I have the honor to present herewith the report of the Office of Experiment Stations for the fiscal year ended June 30, 1904.

Respectfully,

A. C. True, *Director.*

Hon. James Wilson, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

Development of Work of Office of Experiment Stations.

The business of the Office of Experiment Stations has been larger in amount and variety during the past year than at any previous time in its history. The great increase in the original investigations under its supervision, as well as in the world's literature of agricultural science, which it is the duty of this Office to review, has made necessary the publication of a much larger number of technical and popular documents. A very extensive piece of work brought to a successful completion during the past year is the combined index of the first twelve volumes of the Experiment Station Record, which it is believed will save much valuable time of agricultural investigators in the Department, the experiment stations, and elsewhere. A gratifying recognition of the importance of the work of this Office, as well as of agricultural colleges and experiment stations, has been made by Congress in its recent provision for the annual printing of the report of the Office. The claims of agricultural education to more definite and adequate recognition in our public school system, as well as in our higher educational institutions, have been more directly and widely presented to teachers and school officers than ever before. The growing interest in this subject throughout the country is shown by the demands for information, which have exceeded the ability of this Office to meet with its present resources. Much progress has been made in bringing the Department into closer touch with the farmers' institutes in the several States, and the need of a stronger organization for bringing the results of the Department's work home to the great multitude of farmers who attend the institutes has been clearly revealed. The affairs of the agricultural experiment stations in Hawaii and Porto Rico have been successfully

managed by the special agents in charge and already useful results of investigations have been published. In Alaska evidence of the feasibility of establishing animal industry has been obtained and the great desirability of experimental inquiries along this line, which will forestall the expense and discouragement likely to attend private ventures, has been demonstrated. In the nutrition investigations steady progress has been made in the elaborate and fundamental inquiries regarding the laws of human nutrition with the respiration calorimeter and in the more directly practical studies of the nutritive value of cereals, fruits, and meat. The great importance of these investigations is being recognized, not only by scientific and educational institutions throughout this country, but also in many foreign countries. As the result of recent action by Congress, the irrigation and drainage investigations have been put on a more permanent basis. In irrigation a definite and very important field of engineering problems directly relating to the most effective and economical utilization of water in the production of crops has been marked out and lines of work not previously undertaken anywhere have been entered upon. Great enterprises involving the reclamation of large areas of fertile land are being aided by the drainage investigations. The problems of agricultural engineering involved in the construction and use of farm machinery and farm buildings, and the applications of power to agricultural purposes, are coming into greater prominence in our vast agricultural regions, where scarcity of labor is every year a greater drag on agriculture. These problems should be definitely investigated by this Department, and it is hoped that funds will soon be provided for this purpose. The amount of work performed by this Office in connection with the preparation of two exhibits for the Louisiana Purchase Exposition has been very large and burdensome.

Now that the larger divisions of this Department are designated Bureaus, it seems appropriate that this Office, with its large and varied business, should be so designated, especially as this may be done without any change in its organization, and entirely apart from matters relating to salaries or funds.

Agricultural Experiment Stations in the United States.

relations with the office of experiment stations.

The agricultural experiment stations throughout the country are maintaining close relations with this Office and are seeking its cooperation in increasing measure. The Office is endeavoring to aid the stations as far as it can with a view of raising the general level of their work in the directions of scientific accuracy and practical usefulness and to bring the results of their experimental inquiries promptly and effectively to the attention of farmers throughout the United States. It is believed that the Federal funds given to the several States for the maintenance of agricultural experiment stations are now spent more fully for useful agricultural investigations than ever before and that the results obtained by the expenditure of these funds, combined with those contributed by a considerable number of the States, will compare very favorably in scientific thoroughness and practical effectiveness with the results obtained with equal

expenditures of public funds for similar work elsewhere. Under the system of State control of the planning and execution of the experimental operations of the State stations and under the liberal terms of the Hatch Act, through which the States are granted Federal funds for the partial maintenance of their stations, there is necessarily considerable diversity of opinion as regards the proper and wise expenditure of these funds. This fact is often overlooked in criticisms of the work of our stations as related to their use of public funds. With the growth of intelligent public opinion in the several States regarding the most useful functions of the experiment stations, the grade of their work has been raised, and when once the local constituency of a station has understood the real purpose and importance of good agricultural investigations there has been little difficulty in securing the adherence of the managers of that station to the spirit as well as the letter of the laws under which the station is conducted.

It has been the effort of this Office to set before the stations a high standard of efficiency and to exert steady pressure for the improvement of their work. The cases of clear departure from the law in the use of the public funds granted under the Hatch Act have been comparatively few, and in such cases this Office has insisted on such an adjustment of expenditures as would protect the Federal funds. In most instances of this kind the stations have had funds wholly subject to State authority which could be spent more freely than the Federal funds, and so have easily adjusted their accounts to meet the requirements of the Hatch Act. In some cases this has not been practicable and loss of a portion of the Federal fund of the ensuing year has resulted under the regulations of the Treasury Department. Not a year passes but that some stations are persuaded by this Office to forego expenditures of the Federal funds which under the terms of the Hatch Act they might technically insist they had a legal right to make, but which after discussion they are convinced are not in the best interests of their work. Especially has there been effected a more liberal interpretation of the duties and responsibilities of the agricultural colleges toward the stations which are organized as departments of research in these institutions. There are now only a very few of these colleges where the narrow and short-sighted policy of dealing illiberally with the experiment stations is maintained, and this Office will not cease its efforts to bring about a change of view and action by such college authorities on this important matter.

The eighth annual examination of the work and expenditures of the agricultural experiment stations which receive the National funds appropriated under the act of Congress of March 2, 1887 (Hatch Act), with special reference to the fiscal year ended June 30, 1903, was made during the past year in accordance with the authority conferred upon the Secretary of Agriculture by Congress, and a report of this investigation was prepared for transmission to Congress, as required by law. This report was published as Senate Document No. 148, Fifty-eighth Congress, second session. A joint resolution passed by the Fifty-eighth Congress provides for the publication of 8,000 copies of this report, 5,000 of which will be for the use of this Department, and makes it one of the reports to be prepared and published annually without further provision of Congress.

As heretofore, the report was based upon three sources of information, viz, the annual financial statements of the stations, rendered on

the schedules prescribed by the Secretary of Agriculture in accordance with the act of Congress; the printed reports and bulletins of the stations; and the reports of personal examinations of the work and expenditures of the stations made during the year by the Director, Assistant Director, and one other expert officer of the Office of Experiment Stations.

STATISTICS OF THE STATIONS.

The general statistics of the stations as collated for the report of this Office for 1903 are as follows:

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories and, under special appropriation acts, in Alaska, Hawaii, and Porto Rico. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations, maintained under the act of 1887, during 1903, was $1,427,237.73, of which $720,000 was received from the National Government and the remainder, $707,237.73, from State governments, individuals and communities, fees for analyses of fertilizers, sales of farm products, and miscellaneous sources. In addition to this, the Office of Experiment Stations had an appropriation of $161,000 for the past fiscal year, including $15,000 for the Alaska Experiment Stations, $12,000 for the Hawaii Experiment Station, $12,000 for the Porto Rico Experiment Station, $20,000 for nutrition investigations, and $65,000 for irrigation investigations. The total value of additions to the equipment of the stations in 1903 is estimated to be $236,370.61.

The stations employ 737 persons in the work of administration and inquiry, 373 of whom do more or less teaching in the colleges with which the stations are connected. During the year the stations published 371 annual reports and bulletins, which were supplied to over half a million addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

PROGRESS OF THE STATIONS.

The following illustrations of the outcome of the investigations of the stations in certain important lines are taken from the report of this Office for 1903:

As the work of the experiment stations advances from year to year experimental data accumulate in many lines, and from time to time results of great general importance come out of this extensive work. A good example of this at the present time is found in the investigations of the stations relating to cheese making. The importance of this industry in this country is shown by the fact that the production now amounts to 300,000,000 pounds a year, valued at approximately $30,000,000. Though cheese making is probably the oldest dairy industry, very little has been known regarding the principles on which it is based. For centuries it has been carried on largely by rule-of-thumb methods, and the reasons for the various processes and the exact nature of the changes brought about by them have been unknown to the cheese maker. He has been guided mainly by the traditions of his art and has depended upon the skill and judgment acquired through long experience.

Within the past ten years several of the experiment stations of this country have prosecuted systematic studies of cheese making with a view to determining the principles upon which it rests and the means of simplifying and improving its processes. Owing to the large number of factors involved the work has been difficult and for a considerable time the progress was slow. Now, however, the accumulated results are of great practical value, and it may be fairly

claimed not only that this great industry has been put on a rational basis, but also that the art of cheese making has been simplified and its processes can now be more easily controlled, so that good cheese can be more uniformly produced. Besides providing explanations for the important processes in cheese making, the work of the stations has shown that the traditions upon which the empirical rules were founded were absolutely wrong in numerous important particulars and that the judgment of good cheese makers was also erroneous.

Taken as a whole, the investigations on cheese making by the American experiment stations constitute one of the most important contributions of science ever made to any branch of agriculture. A few of the general results of this work may serve to indicate its practical value.

One of the greatest sources of trouble in cheese making has been milk which is tainted, or which contains certain kinds of bacteria and molds. The milk of a single patron of a cheese factory may unfavorably affect the whole supply by causing gassy curds and other difficulties. To remedy this a simple curd test was developed by the Wisconsin station a few years ago by means of which faulty milk may be easily detected.

For ages rennet has been used in the production of curd, and it has been supposed that nothing else could take its place. An extended study of the action of rennet by the New York State Experiment Station led to the conclusion that its effects in curd production are due to a single ferment whose action is essentially like that of pepsin. This raised the question whether ordinary commercial pepsin could not be used in the place of rennet. The Wisconsin Station and the Ohio State University have demonstrated that pepsin may be so used with entire success, and tests with pepsin on a commercial scale in an Ohio cheese factory have resulted in the production of cheese of high quality. Some of the advantages of scale pepsin over rennet extracts are that it is of more uniform strength, keeps better, especially in warm weather, and is free from bacteria and molds.

According to the traditions of cheese making, a temperature of at least 70° F. has been considered the proper one for ripening cheese, but investigations have shown that while high temperatures hasten changes in the casein, since ferments and bacteria are then more active, heat also increases the activity of injurious germs and prevents proper control of the ripening. Hence, too warm curing rooms are one of the greatest causes of poor cheese.

Taking up this line of work, the Wisconsin and New York State stations have made extensive experiments in curing cheese at low temperatures, and recently the United States Department of Agriculture has cooperated in this work. Cold curing at from 40° to 60° F. has in this way been shown to be entirely practicable, and to result not only in improved quality, but in a saving from shrinkage which will more than cover the expense of artificial cooling. Cheese makers are now convinced that they have been holding their cheese at too high a temperature, and there is a very general movement among them to provide facilities for lowering the temperature and keeping it down even in the hottest weather.

Another good illustration of the practical value of the accumulated results of experiment station work may be found in the summary of the investigations on apple growing contained in another part of this report. From this it appears that the stations have issued more than 170 bulletins on this subject. Much useful information regarding the best general conditions for apple growing, and the varieties adapted to different localities, has thus been disseminated, but besides this the results of a large number of original investigations have been reported.

Studies of the flowers of apple trees have shown that some varieties of apples are self-sterile, while others are good pollenizers. In this way the unproductiveness of many orchards is explained, and the way to remedy this is pointed out. The conditions under which the pollen germinates, and how this process is affected by heat, rain, and cold, as well as the value of bees as agents in the distribution of pollen, have been shown. The chemical composition of the leaves, trunk, and roots of the apple tree have been determined both for old trees and for nursery stock, and the draft of the orchard on the fertility of the soil has been shown to be fully as great as continuous cropping with cereals. This has brought out the necessity of fertilizing orchards, and has led to important experiments on the action of different fertilizers on the growth of the apple orchard and of fruit production.

In connection with studies relating to the cultivation of orchards, definite information has been obtained as to the period of growth of the shoots and

roots, the time of formation of the flower and leaf buds, and the methods of controlling the ripening of the wood so as to prevent winterkilling. The value of clean cultivation and of fall cover crops in the preservation of soil moisture and the protection of the roots during the winter has been demonstrated, and it may be safely asserted that never before in this country have apple orchards been given such thorough and rational cultivation as at the present time.

How best to plant apple trees in the arid West and the humid East, or on clay soils and sandy soils, right methods of pruning the roots and training the tops, how to ward off diseases and insect pests and produce uniform and perfect fruit, are problems on which much valuable experimental information has been obtained. As the result of station work we know definitely the controlling factors in the keeping of fruit in ordinary and cold storage and in the utilization of waste fruit by evaporation, or conversion into cider, vinegar, jelly, marmalade, etc.

The large amount of work which the stations have done on questions relating to feeding stuffs has given very important practical results. The saving and use of corn fodder (stover), which was formerly so largely wasted over a large part of the country, is a striking illustration of this. Its value as a feeding stuff has been demonstrated, and the best means of utilizing it have been shown by the stations' work, and their continual agitation has brought about very great improvement in farm practice in this respect. At the nominal value of $1 a ton the corn-stover crop of the United States would be worth at least $100,000,000. While it is not all utilized, a much larger share of it is, and the practice of doing this is steadily increasing.

The inspection of commercial and condimental feeding stuffs, brought about by the experiment stations, has already had the effect of largely holding in check the adulteration of these products and fraud in their sale. In a number of States where the laws have been vigorously enforced by the stations inferior articles have been entirely driven out of the market, because farmers would not buy them unless they received the stations' stamp of approval.

Along with the more scientific work which the stations have done in determining the nutritive value of feeding stuffs there has been much practical work in the improvement of the practice of feeding different kinds of farm animals. The skill which the stations have developed in selecting and feeding animals has of late appealed strongly to the practical feeder. As recent illustrations of this it is worthy of mention that the Missouri station topped the Chicago market with a bunch of steers which it selected and fattened last winter and that at the live-stock show at Chicago in 1903 the grand champion of the fat-animal show was a steer selected from a large lot and fed at the Nebraska station.

In general it may be stated that the excellent showing the agricultural colleges and experiment stations have recently made in the great live-stock expositions has brought about a marked change in the attitude of practical men toward these institutions.

NEEDS OF THE STATIONS.

During the past year a movement looking to the increase of the funds granted by Congress for the use of the experiment stations has been inaugurated, and legislation for this purpose is now pending. After a careful study of this matter in connection with the examination of the work and expenditures of the stations during the past two years I am convinced that the demands on the stations for the extension of their work, which have been aroused by their success in giving direct practical benefits to agriculture in all parts of the country, can not be met without increased funds, and that they are in a position to make effective use of larger means than they now have at their command. Now that this matter is being publicly discussed and the details of legislation have not been decided, it seems proper to state that in the view of this Office it is highly important that in any further act which Congress may pass for the benefit of the agricultural experiment stations the Federal funds shall be explicitly granted for purposes of agricultural research, and the powers and duties of this

Department as related to the supervision of those funds shall be clearly defined.

Some of the needs of the stations for increased funds and the reasons for asking Congress to give them a larger measure of Federal aid were summarized in the report of this Office for 1903, as follows:

As the work of the stations advances demands are being made upon them in various directions which they are unable to meet with their present resources. In considering the needs as well as in judging the work of the stations it is very important to have in mind the conditions under which they are operating. By the terms of the Hatch Act, the stations are organized with a view to the investigation of problems in all branches of agriculture. For this reason, though it would be better theoretically for individual stations to undertake only a few lines of work, and thus refuse to operate in many branches of agriculture, practically it has been necessary to organize them so that their operations may cover the main lines of the agriculture existing in the States in which they are severally located. Thus each station if fully organized would have departments of agronomy (field crops), horticulture, animal husbandry, rural engineering, agricultural chemistry, plant pathology, entomology, veterinary medicine, and, in most States, dairying. If there is any specialization of work in these departments—and no station can do the most effective work unless there is considerable specialization—experts in such subjects as soils, bacteriology, animal physiology, and the different kinds of live stock must be employed. In many States the needs of special industries, such as sugar making, tobacco growing, apiculture, etc., should be provided for. Thus it may be safely said that a station which does not have on its staff experts representing at least ten different branches of the science of agriculture is not adequately equipped for its work. But stations whose income is confined to the Hatch fund can not engage the full time of ten experts, for even if the whole fund were used for salaries, it would provide only an average annual compensation of $1,500 apiece, and this is not a sufficient salary to secure the entire services of a competent agricultural expert. Most of our stations have therefore been compelled to content themselves with an organization of their staffs which is necessarily unsatisfactory. They have either taken most of the time of three or four experts and very little of the time of several more, or they have taken about half the time of the members of the staff generally.

The only way in which it has thus far been possible to organize the work of our stations broadly has been through their connection with the agricultural colleges. To meet the demand for the broad organization of both the colleges and the stations, the time of the officers of these institutions has been very largely divided between teaching and research. We hear a great deal of criticism of our college and station officers which entirely leaves out of account this dual arrangement. For example, it may be said of a station veterinarian that he is doing very little original work, and he is blamed for this, when the fact is that he is paid only $200 or $300 a year from station funds, with the understanding that he shall give a small part of his time to some of the more superficial problems of animal diseases in the region of the station. The rest of his time is given to the college or to State inspection work and most of his salary comes from college or State funds. Theoretically, it might have been better for the station to have dispensed with his services altogether, but the agricultural community would not be content with such an arrangement. Whatever may be thought of the relation of the colleges and stations from an ideal standpoint, it would not have been possible to have operated the stations on the broad plan on which they are now organized without the assistance of the colleges, and on the other hand, many college departments would be crippled or destroyed without the aid of the stations.

During the fiscal year ended June 30, 1902, 52 stations shared in the benefits of the Hatch fund. Twenty-five of these were given additional State aid and 27 did not receive State aid. Of the State appropriations for the stations, 6 did not exceed $1,000, and only 8 equaled or exceeded the Hatch appropriation of $15,000. Several of the State appropriations were exclusively for the support of substations. The total State appropriations for stations and substations were but little more than 51 per cent of the Hatch fund.

The meagerness of the funds available for investigation in the 27 stations not aided by the State is shown by the following figures from the statistical reports

on the expenditures of the Hatch fund in those stations. Their total receipts from the Hatch fund were $405,000. Their expenditures for administration and permanent improvements (salaries, labor, traveling expenses, postage, stationery, libraries, and fixtures) amounted to $313,086.38, or an average of $11,595 for each station. The average amount expended for publications was $760. This leaves an average for each station of only $2,645 for the general expenses of investigations (chemical supplies, fertilizers, feeding stuffs, tools, implements and machinery, scientific apparatus, live stock, seeds, plants, sundry supplies, freight and express, heat, light, water, and contingent expenses). The stations are organized in a number of divisions representing the different branches of agriculture and related sciences; the average number of investigators employed by each station is 10. Dividing the sum available for general expenses by the number of investigators we have an average of $264.50 for each investigator. The whole amount ($2,645) would hardly pay the expenses of a good-sized feeding experiment or a field experiment involving tests in several different localities. How inadequate, then, does such a sum appear to be when divided among 10 investigators. Under these conditions it is not strange that so many problems of the farm remain unsolved; it is wonderful that so much has been accomplished by our smaller stations.

These figures show conclusively that, if our stations are to be continued on the broad basis on which they are at present organized, they must generally be supplied with larger funds for the general expenses of investigations, in order to conduct their work in a thorough and satisfactory manner.

As soon as any station demonstrates its usefulness by results which promote any agricultural industry within a State all the other industries cry out that the station must do work on their problems. At first an attempt was made to meet these demands by the publication of compiled bulletins which might contain considerable information more or less new to most of the readers, but in most cases this is no longer of much avail. Some stations have tried to satisfy the most urgent of such demands by doing a little work on a variety of problems, but as a rule this has been unsatisfactory to all concerned. There is not a station in the country which is not confronted by reasonable demands for investigations of important agricultural problems which at present it is wholly unable to satisfy. In the older States the changing conditions of agriculture have created many problems which are new to the farmers and on which they greatly need help, and in the newer States the extension of agriculture is so rapid that the stations are unable to keep pace with the wholly unfamiliar problems that arise in the farmers' new fields.

In this connection it is well to consider that the areas over which many of the stations in this country are required to extend their jurisdiction are so large that they can not meet the demands for investigations adapted to the various conditions of soil, climate, and rational agricultural practice in their several States. The investigations thus far carried on by the stations in many lines have very clearly brought out the fact that there is a large number of agricultural problems which must be studied in numerous localities before safe conclusions can be drawn. This is especially true with reference to problems relating to the character and management of soils, the use of fertilizers, and the growth of varieties of field and horticultural crops. A large share of the work already done on these subjects by the stations needs to be supplemented by experiments carried on in different parts of their respective States, but this they are unable to do. The greatness of the agricultural regions in whose interest our individual stations are working is rarely realized. Even along the Atlantic coast we have on an average only one station for each 24,000 square miles; France and Germany have eight times as many. The South Central States with their 10 stations are 40 per cent larger than all of France and Germany with their 151 stations; and Texas alone, with one Federal station, is 27 per cent larger than either of these countries. The ratio of stations to area in France and Germany is 96 to 1 as compared with Texas, 28 to 1 as compared with Minnesota and the Dakotas, and 39 to 1 as compared with the Pacific States.

Some of the States have tried to meet the local needs of agriculture by the establishment of substations, but as a rule the funds provided for this purpose have been entirely inadequate.

When the Hatch Act was passed, less than twenty years ago, no country had established experiment stations on the broad plan set forth in that act. The success of our stations has thoroughly demonstrated their usefulness. At the same time they have shown possibilities for the useful extension of their work which were not at all understood when the Hatch Act was passed. Aside from the

needs of the stations growing out of the greater specialization of their work, which calls for the employment of a larger staff, the cost of their equipment with laboratories, apparatus, and other facilities has greatly increased; and the demands for the information which they are able to supply have made the expenses connected with the printing and distribution of their documents much greater than in the early years of their history. An enormous correspondence with farmers has also been developed which must be provided for, and is now in many cases a hindrance to the research work of the staff because of lack of funds for clerical assistance.

In these and other ways the magnitude of the station work at the present time is in itself an important item as related to their financial needs. If the individual stations needed $15,000 per annum for their work a decade or more ago, they certainly need a much larger sum to carry on their work to the satisfaction of the agricultural community at the present time.

The work done by the stations in various lines has brought out clearly the necessity for more fundamental investigations, but such investigations as a rule are costly and only a few of our stations have been able to undertake them. The stations, for example, have made numerous feeding experiments with different kinds of farm animals. Many of these have had useful results, and the work of the stations on this subject as a whole has done much to improve the practice of feeders, but it will be impossible to put this practice on a thoroughly rational basis until we know much more regarding the physiological requirements of animals. Some years ago one of the stations undertook investigations looking to the improvement of the apparatus necessary for the thorough investigation of the nutrition of man. It soon appeared that it could not carry this work to a successful issue without larger resources than it possessed, and it therefore sought the cooperation of the United States Department of Agriculture, with whose aid a special fund was obtained from Congress for this investigation. The work thus inaugurated and maintained resulted, after several years, in a more efficient apparatus than had hitherto existed for this kind of inquiry. By its use our knowledge of the laws of nutrition and the nutritive value of different foods has been materially extended. After this apparatus had been completed, another station undertook to adapt it to use in experiments with large domestic animals. This enterprise proved too great for the limited funds of that station, and again the Department of Agriculture was called upon to contribute thousands of dollars to make the work a success. Through this cooperation the apparatus was put in working order and a series of experiments has been begun which promises to yield very important results.

As long as the stations confined their studies of the varieties of cultivated plants to simple tests of the varieties already produced the work was comparatively inexpensive and very largely unsatisfactory. Now, the breeding of varieties especially adapted to particular regions and uses has been attempted, but only those stations which are supplied with extra funds for this purpose can hope to accomplish much in this line.

Very little has been done in this country in the scientific breeding of animals, and we are as yet largely dependent on importations of breeding stock from foreign countries to maintain the quality of our meat and other animal products. The production of breeds of farm animals especially adapted to the needs of different parts of our country has hardly been attempted. The stations are the public agencies to which such work would naturally be intrusted, but, with one or two exceptions, they have no funds available for this purpose.

In veterinary medicine very few of the stations have been able to provide the equipment necessary for the successful prosecution of original researches. They have therefore been obliged to content themselves very largely with the diffusion of information derived from investigations made elsewhere and the more superficial study of cases of diseases brought to their notice. There is, of course, a large field for the extension of the work of the stations in this direction, but it can not be done without increased funds.

Under present conditions it is useless to expect that in these and many other lines our stations will discover many of the principles on which the permanent improvement of our agriculture must rest. But unless the way is opened for them to seriously attack these fundamental problems their future work will necessarily be comparatively fragmentary and inconclusive. They may, as in the past, obtain many results which can be usefully applied in practice, but they will not be able to furnish a solid foundation for the enlargement of our agricultural industries. The recent work on cheese making, which has been briefly summarized elsewhere in this report, is a good illustration of what may be accomplished in many lines if the financial resources of the experimenters are

adequate for the work undertaken by them. By means of investigations costing thousands of dollars and extending over a number of years the interests of an industry which is now large, but which is likely to be very greatly extended in the future, have been permanently and advantageously affected. The economy of using relatively large sums of money in fundamental inquiries has thus been signally shown.

As pointed out in previous reports, there is another side of the work of the stations which needs to be greatly extended. It is, in many cases, not enough that the stations should discover new facts and principles. They must show definitely how these can be utilized in agricultural practice. This requires that they should be in a position to work outside of their laboratories and experimental plats. They must carry on experiments under actual farm conditions, and on a really practical scale, before it can be truly said that they have demonstrated the usefulness of their new discoveries. It used to be said that this was not the function of the stations, but that the farmers themselves must demonstrate the practical usefulness of the results obtained by the stations. There is, of course, a sense in which this will always be true, for the conditions of no two farmers are exactly alike, and whatever the stations do the farmers will still need to adapt the results to the requirements of their own farms. But, on the other hand, it is often a very expensive proceeding to the farmers to undertake to apply results obtained by the stations on a very small scale to even the general requirements of farm practice. It is usually true that laboratory and plat results must be modified in various ways to make them practically serviceable, and this can be much more economically done by the stations than by the farmers. For example, if a station breeds a new variety of grain, it would be much better and less expensive for the station to retain control of this variety and carry on field experiments with it on a considerable number of farms in different localities than if the seed is at first distributed to farmers indiscriminately. Much of this more practical work can be carried on in cooperation with farmers, but to do it efficiently will require more funds than the stations at present possess.

Since the stations were established under the Hatch Act, the States have materially increased their appropriations for their maintenance, and it may be asked, Why should not the States be called upon to add to the resources of the stations whatever additional funds are needed for their more perfect development? In reply to this it may be said that there are likely in the future to be such demands on the States to provide for the extension of agricultural education in general that it will be increasingly difficult for them to add to the resources of the stations. This has already been the case in a number of States. Thus far, in most of the States, the stations have been aided by appropriations for buildings and equipment which have been for the joint use of the agricultural colleges and experiment stations. The increased interest which is now being manifested in those forms of education which are furnished by the agricultural colleges has had the result that the number of students in those institutions is increasing more rapidly than the facilities provided for them. This is putting additional burdens on the officers of these institutions, many of whom are employed in both college and station, and is making the new buildings inadequate for the purpose for which they were intended. Moreover, outside the colleges there is a rapidly growing demand for secondary schools of agriculture and the introduction of agricultural subjects into the public schools. The States will therefore need to provide largely increased funds for agricultural education, and this is likely to absorb their revenues to such an extent that it will not be practicable for them as a rule to materially increase the resources of the stations.

Thus far the stations have been maintained mainly by National funds, and this policy having been once adopted it seems reasonable that the nation should increase its contributions to the support of these institutions as the demands of their work increase, and thus leave the colleges more free to advance the agricultural education of the people with the aid of State funds. This argument has more importance from the fact that the results of the work of the stations are more and more depended on to furnish the materials on which courses of instruction in agriculture of different grades can be successfully based. If the nation makes the institutions of research in agriculture strong and far-reaching in their work, it will thereby lay the foundation for a system of agricultural education which, if the States and local communities do their duty, will eventually profoundly affect the material and intellectual well-being of the masses of our rural population.

The theory on which appropriations of public money are made to the agricultural colleges and experiment stations is, that since these are institutions for the promotion of an industry on whose success the whole fabric of the nation's

material prosperity depends, all our people are interested in and affected by the results of their work, and therefore it is proper that the people generally should contribute to their maintenance. If such a theory was reasonable when the value of the work of the experiment stations was problematical, it should certainly be much more effective now that they have proved their great usefulness as agencies for the promotion of agriculture throughout the United States.

COOPERATION OF THE STATIONS WITH THE DEPARTMENT.

The amount and variety of the cooperation between the Bureaus and Divisions of this Department and the State experiment stations continue to increase. To provide a regular agency for the settlement of questions of policy which arise in connection with these cooperative enterprises a standing committee on cooperation was created during the past year by an order of the Secretary of Agriculture. This committee consists of the Director of this Office and the Chiefs of the Bureaus of Plant Industry and Soils. Several conferences have already taken place between this committee and the executive committee of the Association of American Agricultural Colleges and Experiment Stations, at which important general questions regarding the functions of the Department and the experiment stations have been discussed.

Summary of cooperative enterprises between the Department and the colleges and stations.

Station.	Bureau, Office, or Division.	Line of work.
Alabama	Plant Industry	Three diversification farms.
	Plant Industry	Inoculating crimson clover, vetch, and alfalfa with nitrogen-gathering bacteria.
	Plant Industry	Experiments on shedding of cotton boll.
	Plant Industry	Experiments with trucking crops.
Arizona	Plant Industry	Experiments on date palms.
	Plant Industry	Drug-plant investigations.
	Plant Industry	Testing berseem and the overflow of lands on Colorado River, near Yuma.
	Soils	Alkali reclamation.
Arkansas	Experiment Stations	Irrigation investigations.
California	Plant Industry	Fiber investigations.
	Plant Industry	Viticultural investigations.
	Plant Industry	Date investigations, ultimately designed to include opuntias, grapes, olives, and other desert-loving plants.
	Plant Industry	Testing and propagating garden for new productions.
	Plant Industry	Buying seeds and plants to test.
	Chemistry	Effect of environment on chemical composition of sugar beet.
	Experiment Stations	Nutrition investigations.
Colorado	Plant Industry	Drug-plant investigations.
	Chemistry	Effect of environment on chemical composition of sugar beet.
	Animal Industry	Investigation on value of beet pulp in steer feeding.
	Experiment Stations	Irrigation investigations.
Connecticut (Storrs)	Experiment Stations	Nutrition investigations.
	Plant Industry	Alfalfa investigations.
	Plant Industry	Testing varieties of sweet corn and pole beans.
Delaware	Plant Industry	Cover crops for orchards.
Georgia	Plant Industry	Diversification farms.
Idaho	Plant Industry	Experiments on trucking crops.
Illinois	Soils	Soil survey.
	Experiment Stations	Nutrition investigations.
Indiana	Plant Industry	Experiments with rusts of grains, grasses, and other economic plants.
	Chemistry	Effect of environment on chemical composition of the sugar beet.
	Experiment Stations	Irrigation investigations.
Iowa	Plant Industry	Experiments on trucking crops.
	Plant Industry	Work on cereals.
	Plant Industry	Fiber investigations.
	Animal Industry	Investigations on breeding of range sheep.
	Experiment Stations	Irrigation investigations.

Summary of cooperative enterprises between the Department and the colleges and stations—Continued.

Station.	Bureau, Office, or Division.	Line of work.
Kansas	Plant Industry	Work on cereals.
	Plant Industry	Fiber investigations.
	Soils	Soil survey.
	Experiment Stations	Irrigation investigations.
Kentucky	Plant Industry	Rotation of crops; meadows and pastures; annual forage crops, and new grasses and forage plants.
	Chemistry	Effect of environment on chemical composition of sugar beet.
Louisiana	Entomology	Cooperation in an attempt to prevent introduction of Mexican cotton boll weevil into Louisiana.
	Soils	Soil survey.
Maine	Plant Industry	Variety tests of vegetables.
	Animal Industry	Experiments in poultry breeding.
	Experiment Stations	Nutrition investigations.
Maryland	Plant Industry	Work on cereals.
	Plant Industry	Experiments on trucking crops.
Michigan	Plant Industry	Fiber investigations.
	Plant Industry	Testing various strains of sugar-beet seed.
	Plant Industry	Experiments on trucking crops.
	Chemistry	Effect of environment on chemical composition of sugar beet.
	Soils	Soil survey.
Minnesota	Plant Industry	Work on cereals and forage and other crops.
	Plant Industry	Experiments on trucking crops.
	Plant Industry	Fiber investigations.
	Plant Industry	Influence of origin of red-clover seed on yield of crop.
	Statistics	Statistics relating to cost of growing field crops and to farm management.
	Experiment Stations	Nutrition investigations.
Mississippi	Plant Industry	Three diversification farms.
	Soils	Soil survey.
Missouri	Plant Industry	Variety tests of vegetables.
	Plant Industry	Diseases of orchard fruits and means of combating them.
	Plant Industry	Study of alfalfa in its relation to Missouri soils.
	Plant Industry	Study of forage crops for the production of beef cattle in Missouri.
	Experiment Stations	Irrigation investigations.
Montana	Plant Industry	Experiments on trucking crops.
	Plant Industry	Feeding experiments on the loco disease.
	Plant Industry	Drug-plant investigations.
	Experiment Stations	Irrigation investigations.
Nebraska	Plant Industry	Variety tests of vegetables.
	Plant Industry	Work on cereals.
	Plant Industry	Experiments on trucking crops.
	Entomology	Investigations of grasshopper conditions during present summer in several western States.
	Experiment Stations	Irrigation investigations.
Nevada	Plant Industry	Drug-plant investigations.
New Jersey	Plant Industry	Experiments on trucking crops.
	Experiment Stations	Irrigation investigations.
New Mexico	Plant Industry	Experiments on trucking crops.
	Experiment Stations	Irrigation investigations.
New York (State)	Plant Industry	Experiments on trucking crops.
	Plant Industry	Growing sugar-beet seed.
	Chemistry	Effect of environment on chemical composition of sugar beet.
New York (Cornell)	Chemistry	Effect of environment on chemical composition of sugar beet.
	Soils	Soil survey.
North Carolina	Plant Industry	Disease-resistant varieties of cotton.
	Plant Industry	Breeding resistant varieties of melons and spraying to prevent melon wilt.
	Chemistry	Effect of environment on chemical composition of sugar beet.
	Soils	Soil survey.
North Dakota	Plant Industry	Influence of origin of red-clover seed on yield of crop.
	Plant Industry	Fiber investigations.
	Plant Industry	Experiments on trucking crops.
	Plant Industry	Work on cereals.
	Soils	Soil survey.
Ohio	Plant Industry	Influence of origin of red-clover seed on yield of crop.
	Plant Industry	Fiber investigations.
	Soils	Soil survey.
Oklahoma	Plant Industry	Fiber investigations.
Oregon	Experiment Stations	Irrigation investigations.

Summary of cooperative enterprises between the Department and the colleges and stations—Continued.

Station.	Bureau, Office, or Division.	Line of work.
Pennsylvania	Animal Industry	Investigations in animal nutrition.
Porto Rico	Plant Industry	Work on mango and other plants.
	Experiment Stations	Irrigation investigations.
Rhode Island	Plant Industry	Experiments on trucking crops.
	Soils	Soil survey.
South Carolina	Plant Industry	Spraying cucumbers and melons to prevent diseases.
	Plant Industry	Work on rice diseases and methods of combating them.
	Plant Industry	Two diversification farms.
	Plant Industry	Experiments on trucking crops.
	Entomology	Insects injurious to growing rice.
South Dakota	Plant Industry	Work on cereals.
	Plant Industry	Variety tests of vegetables.
	Plant Industry	Fiber investigations.
Tennessee	Plant Industry	Work on cereals.
	Plant Industry	Work on rotation of crops, meadows, and pastures, annual forage crops, new grasses and forage plants.
Texas	Plant Industry	Diversification farms.
	Plant Industry	Experiments on trucking crops.
	Plant Industry	Work on cereals.
	Plant Industry	Breeding cotton.
	Plant Industry	Extension of cotton culture in Texas.
	Entomology	Investigation of insects injurious to cotton, exclusive of Mexican cotton boll weevil and the bollworm.
	Soils	Soil survey.
Utah	Plant Industry	Sugar-beet investigations.
	Plant Industry	Experiments on trucking crops.
	Plant Industry	Testing Turkestan muskmelons.
	Chemistry	Effect of environment on chemical composition of sugar beet.
	Soils	Alkali reclamation.
	Experiment Stations	Irrigation and drainage investigations.
Vermont	Plant Industry	Influence of origin of red-clover seed on yield of crop.
	Plant Industry	Experiments on trucking crops.
	Plant Industry	Drug-plant investigations.
	Soils	Soil survey.
Virginia	Chemistry	Œnological industry.
	Chemistry	Effect of environment on chemical composition of sugar beet.
Washington	Plant Industry	Experiments on cereals.
	Experiment Stations	Irrigation investigations.
Wisconsin	Plant Industry	Work on cereals, especially oats.
	Chemistry	Effect of environment on chemical composition of sugar beet.
	Experiment Stations	Irrigation investigations.
Wyoming	Plant Industry	Fiber investigations.
	Experiment Stations	Irrigation investigations.

American Institutions for Agricultural Education.

This year has been notable for encouraging and substantial progress in all phases of agricultural education. Several States which have heretofore been backward about giving aid to their colleges of agriculture have joined in the forward movement and provided more or less liberal funds for additional buildings or for the maintenance of these institutions. The colleges themselves have given much attention to the improvement of their courses of study and to the further adaptation of those courses to the needs of special industries, having due regard meanwhile to the reduction of instruction in agriculture to pedagogic form.

Greater interest than ever before has been manifested in secondary instruction in agriculture and in what may be called the extension work of the colleges—farmers' institutes; short winter courses for farmers; correspondence courses; summer schools for the preparation

of teachers of elementary agriculture, nature study, and school gardening; the organization of experimental clubs among country boys and girls; the preparation of courses in agriculture for rural schools; the preparation and distribution of literature intended to promote these enterprises; the giving of itinerant lectures and in short everything which makes for more wholesome rural conditions. Several of the colleges now have definitely organized departments for carrying on extension work, while others have detailed to this service members of their staff who have other duties.

EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

This Office continues to lend its aid to the forward movement in agricultural education, partly through cooperation with the Association of American Agricultural Colleges and Experiment Stations, in connection with which the Director of this Office is chairman of the standing committee on methods of teaching agriculture. The Annual Report of this Office for 1903 devotes considerable space to articles on different phases of agricultural education. These articles include the following: Progress in Agricultural Education, 1903, by the Director; Farmers' Institutes in the United States, by the farmers' institute specialist of this Office; Development of the Text-book of Agriculture in North America, by L. H. Bailey; Agricultural Economics as a Subject of Study in the Agricultural College, by Kenyon L. Butterfield; and Instruction in Agriculture in Land-grant Colleges and Schools for Colored Persons, by Dick J. Crosby. The educational publications of this Office for 1904 also included a number of bulletins, circulars, and other documents, as follows: Bulletin 127, Instruction in Agronomy at Some Agricultural Colleges, by A. C. True and Dick J. Crosby; Bulletin 139, Special and Short Courses in Agricultural Colleges, by Dick J. Crosby; Circular 52, A Few Good Books and Bulletins on Nature Study, School Gardening, and Elementary Agriculture for Common Schools, by Dick J. Crosby; Circular 53, Report of the Committee on Rural Engineering of the Association of American Agricultural Colleges, by W. E. Stone and others; Circular 55, Relation of the Natural Sciences to Agriculture in Four-year College Courses (this being a report of the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations); Document 706, The American System of Agricultural Education, by A. C. True and Dick J. Crosby; and Document 708, Organization and Work of Agricultural Experiment Stations in the United States, by Dick J. Crosby. As far as his other duties will permit, Mr. Crosby is especially engaged in the educational work of the Office, and is also giving particular attention to the extension work of the colleges in nature study, school gardening, and elementary agriculture. The calls for lectures on the various phases of extension work before teachers and others interested in this work have been more numerous than ever, and while it has been possible for the Office to be represented at a number of State institutes and other meetings attended by a total of about 4,000 teachers, many invitations to appear before such public gatherings have of necessity been declined.

At present the educational work of this Office is merely an incidental feature of its operations. But the situation which has devel-

oped in the progress of agricultural education in this country makes it very desirable that this Department should be in a position to give more effective aid to the rapidly growing movement for the application of the results of scientific and practical investigations to our agriculture through instruction to multitudes of farmers' children in the public schools as well as in the agricultural colleges. The vast majority of the teachers in the rural schools throughout the country are unacquainted with the work and publications of this Department and do not understand how these publications might be utilized for instruction in subjects related to agriculture. Very much needs to be done to overcome the prejudices of school officers and teachers against the introduction of agricultural subjects into the schools. It is becoming increasingly clear that the results of the work of this Department and the experiment stations can not be most effectively and widely utilized by our farmers unless in early life they are taught to think and act along lines in which the application of scientific principles and discoveries is made to appear theoretically rational as well as practically useful. Therefore to secure the greatest benefit to our agricultural people from the expenditure of public funds in the maintenance of this Department and the experiment stations, we should be able to bring the work of these institutions directly to the attention of our educators and school managers in every State and Territory. By regularly cooperating with the agricultural colleges and departments of public instruction in the several States, this Department might effectively bring its work into much closer touch with the educational forces of the country.

A very considerable extension of work in this line might be made with a small addition to the funds of this Office on terms which would enable it to more definitely organize this branch of its service. The basis for this is already laid through the relations of this Office with the Association of American Agricultural Colleges and Experiment Stations and the studies it has already made of the conditions of agricultural education, as related to agricultural research, in this country and abroad. It is only necessary that the Office should be put in a position to broaden its work along these lines and engage more extensively in correspondence and conference with teachers and other school authorities and through appropriate publications and addresses at the larger meetings of educators bring the work of the Department more closely in touch with our educational system and more effectively promote the movement for the teaching of agricultural subjects in our schools.

GRADUATE INSTRUCTION IN AGRICULTURE.

It has not yet been found feasible to continue the Graduate School of Agriculture which was so successfully inaugurated at the Ohio State University in the summer of 1902, owing largely to the fact that no single college has found it practicable to assume the financial responsibility of conducting such an enterprise. However, the Association of American Agricultural Colleges and Experiment Stations has appointed a standing committee on graduate study, of which the Director of this Office is a member, which is charged with the duty of trying to provide means for further sessions of the graduate school. The nature of the courses given at the Graduate School of Agriculture and the fact that experts from all parts of the country are brought

into conference with students who are themselves teachers and investigators in our leading agricultural institutions, make it extremely desirable that the work of this committee be successful.

Graduate departments which afford opportunities for advanced degree work in agriculture are maintained by several of the colleges of agriculture. There are now 40 colleges which thus provide agricultural work leading to the master's degree, and 9 which offer courses in agriculture leading to the doctor's degree.

THE COLLEGES.

The activity of the colleges in providing special buildings and laboratories for instruction in the different divisions of the sciences of agriculture continues unabated. Among the buildings of this nature recently completed are the $50,000 agricultural building in South Carolina, the $150,000 agricultural building of the University of Wisconsin, and the agronomy and animal husbandry judging pavilion and the farm mechanics building of the Iowa State College of Agriculture and the Mechanic Arts. The Nebraska University is erecting a $60,000 building for its school of agriculture.

The appropriations of the year for new buildings at the colleges and for maintenance of these institutions have also been very large. The State legislature of Virginia appropriated $165,000 for buildings, equipment, and improvements at the agricultural college. Iowa College has an addition of $50,000 to its maintenance fund, an appropriation of $95,000 to complete the central building, $45,000 for a dairy building and $10,000 for equipping it, $22,000 for a new dairy farm and $7,000 for equipment, and $54,500 to begin the construction of a heating plant, with several minor items, including $15,000 annually for the experiment station. The college of agriculture of Cornell University is now definitely organized under State support with an appropriation of $250,000 for buildings and equipment. The last legislature of Florida gave the university about $60,000 for maintenance during the next biennium. The Illinois college of agriculture has appropriations for a building for beef cattle, $25,000; another for horticulture, $12,500, and for a storage building for agronomy, $12,500. Minnesota has appropriations aggregating $300,000 for building purposes, including among other items $218,000 for a main agricultural building. There are also many smaller appropriations for barns and other less expensive buildings, for maintenance, and for special lines of instruction.

The reorganization of courses of study and the division of agriculture into specialties along the lines recommended by the committee on methods of teaching agriculture have received increasing attention and are indications of progress in the development of the science of agriculture. The college of agriculture of Cornell University now offers regular four-year courses, which are very largely elective, special two-year courses in general agriculture and in nature study, and winter courses. The University of Maine has added a department of forestry to its agricultural work; the Rhode Island College of Agriculture and Mechanic Arts offers this year for the first time a four-year course in highway engineering, "intended to meet a definite and growing demand for men competent to build better roads," and the

University of West Virginia has organized a department of dairying in connection with the college of agriculture.

The University of Missouri now has a new department known as the Missouri Teachers' College, which proposes to give special attention to the training of teachers in agriculture. Other colleges also are giving attention to the training of teachers for work in agriculture, nature study, and school gardening, largely through summer schools. Such schools have been in session this year at the agricultural colleges in Connecticut, Nebraska, and Tennessee, at the Hampton Normal and Agricultural Institute, Hampton, Va., and at the North Carolina College of Agriculture and Mechanic Arts. The attendance of teachers at the latter institution this year was 977, and about 500 of these took work in agriculture, nature study, and school gardening.

The short winter courses are more and more coming to be recognized as a valuable and legitimate part of college work. Forty-four of the agricultural colleges conducted such courses last year.

Correspondence courses and reading courses for farmers, such as are conducted by the agricultural colleges of Pennsylvania, New York, Michigan, South Dakota, and West Virginia, are valuable features of the extension of these colleges. Another feature of it is the special publication or bulletin, such as the nature-study bulletins and school-garden bulletins issued from the agricultural colleges in New York, Indiana, Rhode Island, Michigan, New Hampshire, Georgia, and Washington, and from the negro institutions at Hampton and Tuskegee. The Ohio State University, the University of Missouri, and the University of Minnesota have issued a number of agricultural bulletins for use in rural schools or intended to promote the teaching of agriculture in rural schools.

Another way of extending the influence of the colleges among the people is through the student unions and the experimental unions, such as are organized in Ohio, Wisconsin, Illinois, Iowa, and New York. There are also in New York, Ohio, Illinois, Iowa, and Texas experimental or agricultural clubs of boys and girls which have been organized largely through the instrumentality of the agricultural colleges for the purpose of arousing among the young people an interest in the study of agriculture and in improved methods of doing farm work.

The financial and statistical reports of the colleges receiving appropriations under the act of Congress of August 30, 1890, which, in accordance with the law, are regularly forwarded to the Secretary of Agriculture, have, as hitherto, been deposited in this Office. On the basis of these reports this Office has published statistics relating to the land-grant colleges for the year ended June 30, 1903. These show that the aggregate value of the permanent funds and equipment of these colleges in 1903 was estimated to be $69,778,463.25; their income, exclusive of the funds received from the United States for agricultural experiment stations ($719,999.50), was $9,248,378.40; the value of additions to their permanent endowment and equipment, $2,743,683.38.

The number of persons in the faculties of the colleges of agriculture and mechanic arts having charge of preparatory classes and collegiate and special classes was 2,461, about one-sixth of this number

being engaged with the preparatory classes. In the other departments the faculties aggregated 1,141, making a grand total of 3,602 persons in the faculties of the land-grant institutions. The students in 1903 were as follows: (1) By classes: Preparatory, 8,801; collegiate classes, 19,161; short course or special, 7,999; postgraduate, 607; other departments, 16,760; total, 52,489. (2) By courses: Four-year.—Agriculture, 3,146; horticulture, 539; household economy, 873; mechanical engineering, 4,475; civil engineering, 2,587; electrical engineering, 2,116; mining engineering, 955; chemical engineering, 188; architecture, 182. Shorter.—Agriculture, 5,505; dairying, 867; horticulture, 367; veterinary science, 811; military tactics, 16,316. The graduates in 1903 were 4,524, and since the organization of these institutions, 53,252.

SECONDARY AND ELEMENTARY SCHOOLS.

Progress has been made during the year along lines of secondary instruction in agriculture, not only in the schools maintained in connection with the agricultural colleges, but also in the separate secondary schools. The nine district agricultural schools in Alabama are now regularly inspected by the State commissioner of agriculture, and it is proposed to give more attention to the agricultural courses in these schools. An agricultural school of secondary grade has been recently opened at Rutherford, Napa County, Cal., under the auspices of the Youths' Directory, of San Francisco. A building with class rooms, laboratories, and dormitories to accommodate 150 boys is now being erected on a ranch of 1,000 acres belonging to the school.

Considerable attention is being given of late to the instruction of women along agricultural and horticultural lines. Simmons College in Boston gives one-year and two-year courses in horticulture for women, and has made arrangements whereby these courses can be continued for two years at the Massachusetts Agricultural College. Wellesley College announces a course in elementary horticulture and landscape gardening, to include lectures on the preparation of soils; the propagation, cultivation, and pruning of plants; school gardens and planting designs. There is a school of horticulture and landscape gardening for women conducted under private auspices at Groton, Mass. The Girls' Industrial College, which was opened at Denton, Tex., in September, 1903, will devote considerable attention to the teaching of horticulture and ornamental gardening, including also instruction in floriculture, dairying, bee keeping, and poultry keeping.

The introduction of agriculture into the primary schools is being widely discussed at meetings of teachers and farmers. The preparation of a number of text-books suitable for this work has given considerable impetus to the movement. As an indication of this, since the appearance of one of these text-books the States of Alabama, Louisiana, North Carolina, Virginia, and Tennessee have passed laws requiring agriculture to be taught in the elementary schools and adopted this text-book for all of those schools. Maryland and Florida have county option in the selection of text-books, and about three-fourths of the counties in the former State have definitely adopted

this text-book. It is stated on good authority that about 12,000 children in North Carolina received some instruction in agriculture last year. The State superintendent of public instruction in Indiana has just prepared a uniform course of study for the elementary schools of the State, in which he recommends an outline course in elementary agriculture, including instruction in soils, plant life, farm crops, and farm animals. The introduction of gardening and some instruction in agriculture in many of the rural schools of Ohio, Missouri, and Illinois has been attended with apparent success.

ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The seventeenth annual convention of this association was held in Washington, D. C., November 17 to 19, 1903. The Director of this Office was a delegate and was reelected bibliographer of the association. A number of other officers of the Department attended the convention and took part in the proceedings. A stenographic report of the proceedings was prepared under the supervision of the Director, and has since been edited by him and Mr. W. H. Beal, of this Office, and the chairman of the executive committee of the association, and issued as Bulletin 142 of the Office of Experiment Stations. Reports were made by the committees on methods of teaching agriculture and indexing agricultural literature, upon both of which the Director of this Office served during the past year. The hope was expressed that the Graduate School of Agriculture might be revived, and the matter was placed in the hands of the committee on graduate study at Washington, whose title was changed to the "committee on graduate study." The Director of this Office outlined and explained the work which the Department has undertaken in connection with farmers' institutes.

A resolution presented by C. E. Thorne commended the reviews furnished by the Experiment Station Record, and suggested an extension of these to include more full abstracts in the case of some of the foreign publications, which are accessible to only a portion of the station workers, and directed the executive committee of the association to urge upon the Secretary of Agriculture the securing of additional funds for this purpose.

The standing committee on agricultural engineering presented its first annual report, which was subsequently published as Circular 53 of the Office of Experiment Stations.

Interesting sessions were held by the different sections of the association, and a large number of topics were presented. Much attention, in the papers and in the animated discussions which followed them, was given to methods of investigation and of instruction.

EXHIBITS AT THE LOUISIANA PURCHASE EXPOSITION.

During the past fiscal year this Office has done a large amount of work in the preparation of two exhibits for the Louisiana Purchase Exposition at St. Louis. First, as a branch of the Department of Agriculture, the Office prepared an exhibit showing its functions as a Governmental agency for the promotion of agricultural education

and research and for the management of the experiment stations in Alaska, Hawaii, and Porto Rico, and of special investigations on human nutrition and on irrigation. Second, the Office has participated in the collective exhibit made under the auspices of the Association of American Agricultural Colleges and Experiment Stations to illustrate the progress of the institutions established under the acts of Congress of July 2, 1862, March 2, 1887, and August 30, 1890.

THE EXHIBIT OF THE OFFICE OF EXPERIMENT STATIONS.

An exhibit of the work of this Office has been made under the general direction of the representative of the Department on the Government board and is installed in the Government Building on the fair grounds. Dr. Walter H. Evans, of this Office, was designated to have immediate charge of the preparation of the exhibit and its installation.

The relations of this Office with the Department and with the experiment stations organized under the Hatch Act of 1887 are shown by a series of charts, sets of publications, etc. The publications of the Office of Experiment Stations are shown and a special exhibit prepared of the Experiment Station Record, in which it is shown that the 14 volumes of that journal thus far issued contained abstracts of articles, the originals of which if brought together would make over 700 volumes of the same size as the Record. In addition there have been printed in the Record over 100 leading articles, giving the results of research or summaries of knowledge along lines of economic importance to agriculture.

The exhibits of the insular stations consist mostly of agricultural and horticultural products of the different countries. The exhibits of grains from Alaska and tropical fruits from Hawaii and Porto Rico have proved very attractive and suggested many inquiries from the persons in charge of the exhibit relative to the countries in which the products were grown, their agricultural possibilities, etc.

As illustrative of the Office work in irrigation, exhibits are shown in two pavilion cases, one of special construction provided with a centrifugal pump, flumes, weirs, water registers, current meters, evaporation tank, etc., so adjusted that the actual operations of irrigation investigations could be shown. In the second case a number of forms of apparatus are exhibited which illustrate the different types of water registers, current meters, etc., their development and improvement.

The investigations in human nutrition are represented by a model of the modified respiration calorimeter, a bomb calorimeter, and material illustrating some investigations carried on under the auspices of this Office. Among the latter are losses of meat due to cooking, shown by models of cooked and uncooked meats, together with bottles showing the proportionate amounts of the different constituents lost; an exhibit of flour and bread, in which the amount of flour from 5 pounds of wheat, resulting from three different methods of grinding, are shown, also the constituents of a loaf of bread made from three kinds of flour, and studies of the digestibility of the different kinds of bread; a number of samples of the daily rations of the fruitarian

colony studied in California, and a series of jars showing the percentage composition of a number of the more common foods.

The exhibit, on the whole, has proved an unusually attractive one, and it has been found necessary to keep some one constantly at the exhibit to answer questions regarding the work of the Office and its relations to the Department and to the several State stations.

THE EXHIBIT OF THE AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The movement to prepare a collective exhibit illustrating progress in instruction and research in agriculture and mechanic arts was instituted at the 1901 meeting of the Association of American Agricultural Colleges and Experiment Stations, in Washington, and two committees were appointed to consider the matter, one representing agriculture and the other mechanic arts. At the Atlanta meeting of the association in October, 1902, these committees reported in favor of exhibits. The two committees were consolidated into one as an exposition committee, as follows: W. H. Jordan, chairman; A. C. True, secretary; W. T. Harris, H. J. Waters, W. M. Hays, W. E. Stone, T. F. Hunt, C. F. Curtiss, J. K. Patterson, and H. W. Tyler. At the same meeting the executive committee of the association was charged with the duty of soliciting from Congress an appropriation for installing and maintaining the exhibit. Congress appropriated for this purpose $100,000, to be expended upon authority of the Government board, the Louisiana Purchase Exposition Company to provide the necessary space for the exhibit.

The Government board intrusted the work of planning, collecting, and installing the exhibit to the exposition committee of the association named above, and made the Director of this Office, as secretary of the committee, the special representative of the committee in its relations with the board, responsible for the proper expenditure of the funds granted by Congress for this purpose. To have immediate charge of the business relating to this exhibit Mr. James L. Farmer, of Tennessee, was appointed chief special agent, and made his headquarters in this Office until preparations for the exhibit were sufficiently well advanced to make it desirable to open them on the exposition grounds.

It was planned from the first to illustrate the distinctive educational and research work of the land-grant colleges and the experiment stations in the United States—that is, those features of education and research which differentiate these institutions from other educational and scientific institutions. It was concluded that this purpose could best be accomplished by making the exhibit collective, i. e., assembling the contributions from the various institutions represented according to subjects rather than by institutions, due credit, of course, being given to all contributors to each group. The general exhibit was therefore grouped according to the main divisions of agriculture and mechanic arts, and the exhibits in the several divisions were assembled and arranged by experts selected by the committee. The exhibits occupy a total space of 16,000 square feet in the northwest section of the Palace of Education, and include the following:

I. Exhibits of the Bureau of Education and the Office of Experiment Stations, showing the relations of the United States Government with education in agriculture and mechanic arts, and with institu-

tions for research in agriculture, the exhibit of the Bureau of Education being prepared under the direction of Dr. W. T. Harris, and that of the Office of Experiment Stations under the direction of the Director of this Office.

II. Agricultural exhibits, classified as follows:

(1) Agronomy, or plant production: Soils, by Prof. M. F. Miller, Ohio State University; fertilizers, by Director E. B. Voorhees, New Jersey Agricultural Experiment Stations; plant laboratory, by Dr. Walter H. Evans, of this Office; field crops, by J. I. Schulte, of this Office; horticulture and forestry, by Prof. S. B. Green, University of Minnesota; plant pathology, by F. C. Stewart, New York State Agricultural Experiment Station; economic entomology, by Prof. Clarence P. Gillette, State Agricultural College of Colorado.

(2) Zootechny, or animal industry: Animal husbandry (investigations), by Director H. P. Armsby, Pennsylvania Agricultural Experiment Station; animal husbandry (instruction), by Prof. Thomas F. Hunt, Cornell University; veterinary medicine, by Prof. D. S. White, Ohio State University.

(3) Agrotechny, or agricultural technology: Dairy laboratory, by Prof. E. H. Farrington, University of Wisconsin; sugar laboratory, by Director W. C. Stubbs, Louisiana Agricultural Experiment Stations.

(4) Rural engineering, or farm mechanics, prepared under the direction of Dr. Elwood Mead, of this Office.

(5) Rural economy, or farm management, prepared under the direction of Prof. F. W. Card, Rhode Island College of Agriculture and Mechanic Arts.

(6) Inspection, by Director M. A. Scovell, Kentucky Agricultural Experiment Station.

(7) Biological sciences, by Dr. G. E. Stone, Massachusetts Agricultural College.

III. Mechanic arts exhibits classified as follows:

(1) Civil engineering, by Prof. Anson Marston, Iowa State College of Agriculture and the Mechanic Arts; mechanical engineering, by Prof. W. F. M. Goss, Purdue University; electrical engineering, by Prof. Bernard V. Swenson, University of Wisconsin; mining engineering, by Prof. S. B. Christy, University of California; technical chemistry, by Prof. W. H. Walker, Massachusetts Institute of Technology; drawing and shop practice (including textile and trades), by Prof. F. Paul Anderson, Agricultural and Mechanical College of Kentucky; domestic science, by Prof. Maude Gilchrist, Michigan State Agricultural College.

Provision was also made for an exhibit of stock and grain judging, which is being conducted as a normal school of instruction in Live Stock Congress Hall, a large pavilion erected by the Exposition company in the agricultural section of the fair grounds. This is in charge of a subcommittee, consisting of Prof. C. F. Curtiss, of the Iowa Agricultural College; Prof. H. J. Waters, of the Missouri Agricultural College, and Prof. W. M. Hays, of the Minnesota Agricultural College.

The feature which distinguishes this collective exhibit from any previous exhibit of the colleges and stations is the prominence given to instruction in agriculture and mechanic arts. Much attention has been given to exhibits which show working laboratories embodying

the best features in the way of apparatus and illustrative material to be found in the different colleges. There are five such laboratories—a plant laboratory, a soil laboratory, a dairy laboratory, a sugar laboratory, and a stock-judging pavilion. The other exhibits are made up largely of pieces of machinery and apparatus, models, charts, specimens of handicraft, photographs, transparencies, mounted and unmounted specimens, and publications.

The exhibit of this Office occupies space on three sides of a central pavilion. It includes an electrical-display machine showing prominent features in the origin, distribution, and work of agricultural experiment stations throughout the civilized world; maps and charts showing the location of these stations, the value of their investigations, etc.; bound publications of this Office and the experiment stations, and about 200 text-books, manuals, and reference books written or edited by experiment station men; specimens of circulars, press bulletins, and other special publications of the stations, and wing frames containing photographs, charts, and plans illustrating some of the buildings, and other equipment of the experiment stations, as well as school gardens and other extension work promoted by this Office.

Relations with Foreign Institutions.

The revision of Bulletin 112, Agricultural Experiment Stations in Foreign Countries, has now been completed, and the bulletin is in the hands of the printer. It contains accounts of about eighty more stations than were listed formerly. This is an indication of the substantial growth that the experiment station movement has been making in foreign countries during the past two years. The movement has something more substantial to show, however, than mere growth in the number of stations. The stations are in many instances provided with more liberal funds than formerly, and a number of them have been provided with new buildings erected with especial consideration for the needs of agricultural investigation.

Probably the most notable addition to the list of experiment stations is the Central Experiment Station in Cuba, which has been located at Santiago de las Vegas, in Habana Province, about 12 miles from the city of Habana. The station is provided with a tract of 180 acres of land, upon which a number of buildings are standing, and has an appropriation of $75,000 a year. It starts out with departments of agriculture, animal industry, horticulture, chemistry and soil physics, botany, and plant pathology. The director of the station is Prof. F. S. Earle, late of the New York Botanic Gardens.

The past year has also been marked by considerable progress in agricultural education in foreign countries. Among other new agricultural institutions, the Imperial Agricultural College of India, endowed with $150,000 by Mr. Henry Phipps, of Pittsburg, Pa., is probably the most notable. This institution will be located at Pusa, and will include a high-grade agricultural college and central research station, an experimental farm, and a cattle-breeding farm. The funds yielded by the endowment will be supplemented with appropriations from the Imperial treasury.

Japan also has a new agricultural college, the third to be established in that country, which has been located at Morioka, under the directorship of a graduate of the Michigan Agricultural College. In

France a colonial school has been established in connection with the university at Nancy for the purpose of giving instruction in forestry, agriculture, economics, etc., to prepare students for positions in the French colonies.

The Province of Nova Scotia has established an agricultural college on its farm at Truro, where a $30,000 agricultural building has been erected. In the Province of Quebec a royal school has been established for the purpose of establishing and carrying on agricultural schools and experimental farms in different districts.

Much attention is being given in a number of foreign countries to the preparation of teachers for giving instruction in elementary agriculture, nature study, and school gardening, and also to the giving of practical instruction to women in agriculture and horticulture. Last year eleven teachers were sent from Canada to agricultural institutions in this country to prepare for nature-study work in the rural schools of the Dominion. In the British West Indies the Imperial Department of Agriculture is devoting much attention to the preparation of teachers in agriculture, and in the British Islands and Germany schools for the training of women in horticulture and floriculture are being developed. In the latter country a school of this nature has recently been established at Godesberg, on the Rhine.

In all the foreign countries giving attention to instruction in agriculture of secondary or elementary grades various forms of itinerant instruction—traveling teachers, traveling dairy schools, farmers' institutes, winter schools, and other forms of university extension—are the subject of careful consideration and experiment. The trend of this instruction and the increasing attention devoted to it are indications that it is considered an essential feature in the systems of education in those countries.

The Farmers' Institutes.

As stated in my previous report, a farmers' institute specialist was appointed in this Office April 1, 1903, and since that time work in the interests of the farmers' institutes throughout the United States has been a regular and distinct branch of the work of this Office and has been in charge of Prof. John Hamilton.

DEPARTMENT AID TO INSTITUTES.

The duties of the farmers' institute specialist during the year have been those of organizing the work of the office, of securing information as to the conditions of the institute work in the United States and in foreign countries, and of rendering assistance to the several State directors and institute lecturers through correspondence, personal visits, and the sending out of agricultural literature.

A complete list of institute lecturers in the employ of the State directors was secured and published as Circular No. 51 of this Office, and later a revised edition of this circular, corrected to June 1, 1904, was prepared and issued. Copies of this publication were sent to all of the directors of the agricultural experiment stations of the country with the request that they select from it and add to their mailing lists the names of such persons as are not already receiving

their publications. This request was quite generally complied with and numerous expressions of appreciation have come from the lecturers to whom the bulletins have been sent. A similar request was made to the Division of Publications of this Department with equally satisfactory results.

Copies of the laws enacted by the several States, including those of the Province of Ontario, Canada, relating to farmers' institutes, were collected and published as Bulletin No. 135 of this Office. Full statistical reports were sent in by the directors of institutes, giving the condition of the work in their several States and Territories. These reports were collated by the institute specialist and printed in the annual report of this Office.

Acting upon a suggestion made by Mr. W. L. Amoss, director of farmers' institutes of Maryland, a room was secured and fitted up in the Agricultural Building at the St. Louis Exposition for use as a headquarters for the farmers' institute workers. Through the courtesy of Prof. F. W. Taylor, chief in charge of the agricultural exhibit, room N in the gallery of that building was assigned for this purpose, and a custodian provided by the Exposition authorities was placed in charge. A card register was provided for the enrollment of institute visitors, and a question box with suitable cards upon which to write the queries was placed in the room for the use of any who may desire information respecting the institute work or that of the National Department of Agriculture. The cards are taken from the box from time to time and forwarded to the office in Washington for reply.

Arrangements have been completed with a number of scientific experts for the preparation of sets of photographs from which to prepare lantern slides illustrative of important agricultural subjects. Each set of photographs is to be accompanied by a syllabus containing explanations of each slide and provided with full references to the literature of the subject. The author of each illustrated lecture has been requested to add an appendix to his syllabus in which there will be given such statistical data relating to the subject as may be useful, the purpose being to distribute the syllabuses among the audience to be kept for future reference.

Correspondence has been opened with the representatives of foreign nations for the purpose of securing information respecting the methods in use in the older countries for the development of their agriculture. Data have also been received from the principal steam railway systems of the United States and Canada, showing the extent to which they have cooperated in the farmers' institute work and in advancing the interests of agricultural people in the sections through which they run.

The institute specialist has visited during the year twenty-three States and one Territory for the purpose of attending conventions of agricultural representatives and has delivered before these conventions twenty-nine addresses. He has been unable to attend all of the meetings for which invitations have been received, owing to conflicting dates and to the necessity for giving attention to correspondence and to the other duties of the office.

The year has been largely devoted to becoming acquainted with the conditions that exist in institute affairs throughout the country

and to the study of these conditions with a view to the solution of some of the problems that confront institute workers in the several States.

PROGRESS OF THE INSTITUTES.

The progress of the institute work throughout the country during the past year has been fully equal to that of any year in the past. There is also a growing appreciation of the value of the instruction that is being given by the institute lecturers and a firmer belief in the practicability of the methods that the institutes have adopted for conveying information to farmers. This is evidenced by the demands that come to the State directors for a much larger number of meetings than they are able to supply.

The expansion of the work, so far as increasing the number of days of institutes is concerned, will be very little if any more rapid than as additional funds are provided for institute support. The reports for the year ended June 30, 1904, show that the institutes are costing an average of about $42 per day each. This sum provides for the salaries and traveling expenses of the lecturers, the heating, lighting, janitor service, and renting of halls; the cost of printing, advertising, and postage, together with such other minor incidental expenses as are connected with the holding of an institute meeting. This average is probably as low as will be possible, for in arriving at it States are included in which the lecture service is gratuitous so far as the salaries of the lecturers are concerned, and in which the local committees provide for hall rent and meet all other local expenses.

NEEDS OF THE INSTITUTES.

As a result of personal observation and of information received from other sources, there seem to be at least three directions in which improvement of the institutes is greatly needed. There is need, first, for better organization of the work in the several States; second, for more money for institute purposes, and, third, for an increased number of efficient workers. There are minor embarrassments that retard the work, due to local conditions peculiar to each State, but in most instances these would be readily overcome if the three great needs referred to were adequately met.

If the farmers' institutes of any State are to become efficient features of its educational system, the first quality that they must possess is that of permanency. They must be so organized as not to be dependent for existence or efficiency upon the capability or life of a single individual. The organization and government must be upon lines similar to the organization and government of other public institutions that have lived and prospered notwithstanding the vicissitudes of time and the loss of leaders. It must be an organization with its purposes recorded and the means for the accomplishment of these purposes clearly and definitely known, not in a general way and by one man only, but in detail and by many.

The form of organization most approved is that of a strong, local, permanent organization in every institute district, with fully and clearly defined duties and powers, the whole system to be subject to the oversight and limited control of a central State authority whose duties and powers are prescribed by law.

An examination of the laws controliing institutes in the several States and of the practice in States in which no legislation has yet been had show how far short most have come of this ideal. This condition is explained and excused by the fact that so long as the institutes were in their formative and experimental stage and their value not generally known it was important and unavoidable that a variety of methods should be tried in order to discover whether they had any right to exist. But now that their usefulness is conceded and their perpetuity and development are desired, the question of form of organization best adapted for carrying out their purposes becomes of great importance and ought to be seriously considered by those having institutes in charge.

The second great general need of the institute movement is more money with which to carry on the work.

Reference has already been made to the expansion of this movement and to the fact that this is limited by the money at the disposal of the directors. The need, however, for additional money is felt in some of the States much more than in others. In eight States and Territories no appropriation is made by the legislatures for institute purposes, and the work is dependent for support upon the amount contributed by the agricultural colleges or experiment stations, supplemented by individual subscriptions. In nine other States and Territories the appropriations by the legislatures were $1,000 or less, and in eight other States the appropriations by the legislatures were from $1,200 to $2,000 per year. The twenty-five States and Territories just referred to have a total population of 25,000,000, of whom 10,000,000 are engaged in agriculture. These States appropriated last year altogether only $20,344 for farmers' institutes, which is less than 2 mills to each rural inhabitant per year, while a single other State, with an agricultural population of only a little more than 1,000,000 (1,077,661), appropriated $21,500 for the same period. It is manifest that before the institutes in these twenty-five States can be extended or greatly improved their legislatures will have to grant them increased support.

One of the first duties of the institute workers, therefore, in these States, as well as in others in which inadequate appropriations are made for institute support, is to see that the subject is brought to the attention of the lawmaking bodies in such a way as to secure a proper recognition for this work.

The third important general need of the institutes is an adequate supply of competent lecturers. These must be acquainted with the science as well as with the practice of agriculture. The agricultural colleges can not under present conditions meet the demand for trained institute lecturers, and special means must therefore be employed to give these lecturers the training and information which they need.

Agricultural science is advancing so rapidly that unless those who are to give instruction in agriculture at the institutes devote a considerable part of their time to study and reading they will soon become unfit for their work as instructors. The lecturer out of college and not identified with the experiment-station work is liable to fall behind in his knowledge of the new discoveries that are continually being made, and unless he has some proper opportunity for becoming informed, will soon cease to be a competent or safe teacher.

Thus far the State directors of institutes have depended for their

supply of scientific teachers upon the agricultural colleges and experiment stations, and upon practical farmers for the discussion of methods in farm management. The work, however, has expanded so rapidly as to make it impossible for the colleges to supply the number of men required, and accordingly some of the States are making an effort to increase the efficiency of their lay institute workers by bringing them together as a normal class for purposes of instruction, the sessions continuing from one to two weeks. Such a class of institute workers was held last year in New York for one week at the Geneva Agricultural Experiment Station, and one at the Cornell University. Other States are planning for the establishing of similar classes.

The fact is now recognized that bulletins or printed documents sent out to the lecturers, although they are helpful, can not take the place of systematic instruction given through oral teaching. It is possible, by means of capable teachers, to treat of methods and present what is known upon a particular subject in a way much more effective than can be accomplished by the use of the printed page. The living teacher has opportunity to accompany the facts that he presents with illustrations and explanations that fix them in the minds of his hearers and enable them to comprehend the truth taught more clearly, so that they in turn will be better able to impart it to others.

Precisely how this normal instruction ought to be given and what form of organization will best serve the purpose are not yet clear. Experiments made thus far bring out several practical difficulties in the way of organizing normal schools for institute instruction by any single State.

The first is that the institute lecture force in most of the States is comparatively small. Because of this and by reason of the limited number of instructors available at any one institution, it is almost impossible to divide the lecture force into classes of sufficient number that the instruction given may be suited to the peculiar needs of the several lecturers in the line of their specialties. Unless this can be done each student is obliged to attend all of the lectures, whether the subject is one upon which he desires information or not, and thus during the entire course he may have had but one or two lectures on his specialty.

The second difficulty is that the agricultural colleges and experiment stations are not as yet sufficiently equipped in their teaching force of experts to do more than cover a quite limited range of topics. Some institutions make a specialty of a single phase of agriculture, as animal husbandry, forestry, irrigation, plant breeding, soil physics, or other branch of agriculture, and are not prepared to give instruction in the particular subjects which the institute lecturers desire to teach.

The third difficulty is that no one institution can afford to give the use of its teaching force for the length of time needed to make a course effective. A four or six weeks' term is an impossibility for any agricultural college or experiment station, and yet this is not too long for a class of institute lecturers to devote to the study of their several specialties. One week is about as much as any institution can contribute annually outside of its regular work, and this is too short a period for the proper treatment of the subjects that need to be considered.

For the present, and until the colleges have been greatly strengthened and the institute force greatly enlarged, it would seem to be necessary for several States to unite in a normal school to be held at different institutions in successive years, to be equipped with a teaching force contributed by each. This would overcome the difficulties mentioned and make it possible to classify the students and thus enable them to devote their time to subjects that more nearly relate to their several specialties. No one institution would be seriously embarrassed by the loss of the number of its teaching force which it would be called upon to furnish, and the additional number of subjects offered in such a school would give character to the meeting and enthusiasm to the teachers and scholars that would do much to popularize it and to give it standing among educational institutions.

An essential feature of a school that is to train institute lecturers is that it shall be in contact with field demonstrations, or experiments in agriculture that are conducted along scientific lines. By changing the location of the normal school each year to a different institution the students would have the advantage of contact with a wide range of experiment work and thus be far better equipped for giving instruction than would be possible if they had only visited a single institution. The expense to the students would be but slightly increased, and the extended acquaintance with fellow-workers and college experts thus formed would be of lasting benefit. States might be grouped whose agricultural interests are most similar, as, for instance, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Ohio. These six States represent an aggregate institute force of 226 lecturers. Thirty-three of these lecturers are connected with the experiment stations of their several States, or with the faculties of their agricultural colleges, leaving 193 who would be likely to be in attendance at a school formed by the union of the six States designated.

It is reasonable to expect that others also, knowing of the normal school of instruction provided and of its high character, would be attracted in perhaps considerable numbers and thus add to the classes that would annually assemble.

In the appropriation acts making provision for the work of this Office in relation to the institutes it is made our duty to bring the results of the work of this Department before the farmers attending the institutes. As the result of this provision we have received a large number of calls for the personal attendance of officers of the Department at the institutes, and the State directors of institutes are constantly urging the Department to give them more assistance in this direction. Under present conditions most of these calls must be refused. It is only occasionally that the services of the experts in the employ of the Department can be given to the institutes, and it is impracticable that such service shall be rendered in any systematic way. What is needed is the organization of a relatively small force of Department lecturers who can give their entire time to the preparation and delivery of lectures based on the publications of the Department and other information which they could obtain at the Department. These men, going into all the States and Territories and explaining the work and publications of the Department to the hundreds of thousands of farmers who attend the institutes, would perform a most valuable service in bringing home to the agricultural

public the results of the Department's work and increasing the usefulness of its publications. The establishing of such a corps of agricultural workers whose entire time would be devoted to institute work would not only meet the demands of the States for assistance, but would also bring the Department in a personal and helpful way into direct contact with agricultural people all over the country and increase its value to farming people many fold.

There is special reason for the organization of such a body of men in the fact that it is clear there is needed a more effective means for the dissemination of the agricultural information which the Department is securing. Since 1888 this Department has had prepared 5,771 separate publications relating to agriculture, most of them of great value to farmers. Of these there were printed and distributed during that period 82,735,580 copies. Tests made in farmers' institute meetings reveal the fact that very many farmers do not read these publications in such a way as to be able to avail themselves of the information which they contain, or even to become aware of the scope of the work which the Department has undertaken for the benefit of agriculture, or of the great value of the discoveries which it has made.

A well-equipped lecture force would call attention to what is being done in the interest of agriculture throughout the world, and particularly keep farmers informed as to the latest and most practical truths which this Department and the agricultural experiment stations have demonstrated to be of value. These lecturers could, moreover, assist in the normal courses established for the training of the local lecturers in the several States.

The fact that almost every European country employs a force of men who give instruction in agriculture in their public schools and lecture before societies of farmers upon agricultural topics is ample proof, if any were needed, of the value, importance, and practicability of this kind of work.

Publications of the Office.

The publications of the Office may be conveniently grouped in four main classes: (1) Experiment Station Record, which gives a technical review of the current literature of agricultural investigation throughout the world, and Experiment Station Work, which is published periodically in the Farmer's Bulletin series of the Department, and gives a popular summary of some of the more salient practical results of the work of the experiment stations. To these should be added the bimonthly list of experiment station publications which the Office has recently undertaken to publish. (2) Publications relating to the food and nutrition of man, consisting of technical and popular bulletins, circulars, etc., reporting or based upon the results of nutrition investigations conducted under the auspices of the Office. (3) Publications relating to irrigation and drainage, which include reports, technical and popular bulletins, circulars, etc., giving the results of the irrigation and drainage investigations of the Office. (4) Miscellaneous publications, including those relating to agricultural education in general, proceedings of the Association of Agricultural Colleges and Experiment Stations, and of the Association of Farmers' Institute Workers, annual reports of the Director and of the Office of Experiment Stations, and similar publications.

During the year the Office published 57 documents, aggregating 5,339 pages, as compared with 44 documents, containing 4,112 pages, the previous year. These documents include 12 numbers of Experiment Station Record, with a combined index of the first 12 volumes of the Record, 16 technical bulletins, 1 bulletin of the Porto Rico Experiment Station (English and Spanish editions), 2 reports, 6 Farmers' Bulletins (including 3 numbers of the subseries Experiment Station Work), 8 circulars, and 3 articles for the Yearbook of the Department. One other number of the Experiment Station Record, 5 technical bulletins, 2 Farmers' Bulletins, 2 circulars, and 4 miscellaneous documents, containing about 600 pages, were prepared and submitted for publication before the close of the fiscal year. The policy of reprinting separates of individual articles contained in larger reports has been continued with satisfactory results. Fifty-four such separates, aggregating 1,241 pages, have been reprinted in editions of varying size to meet the actual demands for the articles. Several documents, particularly those relating to the work and expenditures of the State agricultural experiment stations, as well as of those of Alaska, Hawaii, and Porto Rico, which were formerly printed separately by Congress, were combined in the Annual Report of the Office of Experiment Stations, for the printing of which Congress has now made special provision.

Several of the earlier technical and farmers' bulletins of the Office were exhausted during the year and were reprinted, in many cases with more or less important additions and corrections.

EXPERIMENT STATION RECORD.

During the year the fifteenth volume of Experiment Station Record has been issued. This consisted of twelve numbers, issued monthly, the last number being the name and subject index to the volume. The volume comprises 1,247 pages of closely printed matter, and contains abstracts of 380 experiment station bulletins, circulars, etc., 47 annual reports of the stations, and 181 publications of this Department. In addition, there were a very large number of abstracts of foreign publications and articles issued in scientific journals, proceedings, reports of societies, etc. In all, there were 4,376 separate articles abstracted in the volume. These abstracts were classified by subjects, the total number under each subject being as follows: Chemistry, 296; botany, 101; fermentation and bacteriology, 23; zoology, 70; meteorology and climatology, 109; air, water, and soils, 159; fertilizers, 155; field crops, 256; horticulture, 387; forestry, 116; seeds and weeds, 61; diseases of plants, 209; entomology, 490; foods and nutrition, 296; animal production, 297; dairy farming and dairying, 233; veterinary science and practice, 789; agricultural technology, 8; agricultural engineering, 170; miscellaneous, 151.

Of the 1,247 pages in the volume, the abstracts comprised 927 and the indexes 107 pages. In addition, there were 65 pages of editorial notes, 83 pages of special articles, and 65 pages of miscellaneous notes relating to the experiment stations and similar institutions of the world. The following topics were treated in the editorial notes: The mission of the farmers' institute; organization of farmers' institutes; introduction of agriculture at the Mount Hermon school; September

meetings of scientific bodies—National Irrigation Congress, American Veterinary Medical Association, International Congress of Hygiene and Dermography, American Pomological Society, and Society of Horticultural Science; irrigation in Italy; State aid of the experiment stations; need of increased funds for the stations; experiment station work in Alaska; farm mechanics as a department of agricultural instruction; report of the Secretary of Agriculture for 1903; the personnel of the Department of Agriculture; the American Association meeting at St. Louis; rural economics at the St. Louis meeting; acquisition of the nitrogen of the air by calcium carbid; agricultural research and the Carnegie Institution; Government aid to agriculture in Hungary; investigations on the flow of maple sap; work of the bureau of agriculture in the Philippines; experiment stations in the Philippines; a card index to periodical literature on agricultural science; bimonthly list of experiment station publications; a respiration calorimeter for farm animals; rural economics as a department of agricultural education; instruction in rural economics in European countries; the agricultural appropriation act, 1904–5; inauguration of experiment station work in Cuba; an experiment in secondary agricultural instruction; Levi Stockbridge, deceased; histological studies in relation to food adulteration; Emile Duclaux, deceased; general index to Experiment Station Record; a decennial summary of station work; and the experiment station in the rôle of newspaper editor.

During the year nine leading articles, specially prepared for the Record, were published. These were as follows: New agricultural building at the University of Wisconsin; Annual meeting of the American Veterinary Medical Association, E. V. Wilcox; New building for farm mechanics at the Iowa College of Agriculture and Mechanic Arts; Convention of Association of American Agricultural Colleges and Experiment Stations; Convention of Association of Official Agricultural Chemists, 1903, H. W. Lawson; Agricultural science at the St. Louis meeting, E. V. Wilcox; New dairy barn at the Kentucky Station, D. W. May; New buildings of the Department of Agriculture, and Respiration calorimeter at the Pennsylvania Experiment Station, H. P. Armsby.

As the result of growth of agricultural investigation the world over, and of our coming into closer contact with this investigation, the scope covered by the Record in its review has steadily broadened. This is inevitable, but it imposes an increasing burden on the editorial force, and it becomes more difficult to confine the abstract matter within the space fixed for the Record. During the year there have been frequent requests that fuller abstracts be given of the articles reviewed. This matter was brought up at the last meeting of the Association of American Agricultural Colleges and Experiment Stations, and after a quite free discussion of the needs from the standpoint of the investigator and agricultural teacher and the limitations of the Record editorial force, a resolution was passed by the convention asking for the consideration of this matter and calling upon the executive committee of the association to lend its aid to secure the object of the resolution.

The request for fuller abstracts must be regarded as entirely reasonable, for many of the agricultural colleges and experiment stations

are but poorly supplied with periodical literature, and are quite remote from large libraries. The fact, however, that the suggestion for fuller abstracts has come from experts in this Department, as well as from experiment station workers, indicates the use which is being made of the Record by investigators who have exceptionally good library facilities. It is practically impossible for instructors and investigators in agricultural science to follow up the literature of their specialties in the original form, even where this literature is readily available, and hence the Record serves as a constant means of economizing their time, directing their attention to articles which they may desire to read in full, and enabling the busy worker to keep abreast of the times. The influence of the Record in increasing the efficiency of experiment station work and advancing it along newer and more original lines, by means of its reviews on the progress of agricultural investigation in the world, descriptions of new methods of work, and its special articles, is very potent.

Experience shows that the Record is used in two ways, viz, as a current review of investigation in agricultural science, and also as a means of bringing together the literature on any subject over a term of years. The permanent value of the Record depends largely on its indexes, and for this reason every effort is made to make the indexes comprehensive and systematic. During the year a general index to the first twelve volumes of the Record was completed and the publication issued. The making of this index was a very laborious and time-consuming operation, but it was performed without additional assistance and practically as an additional piece of work. The index comprises a volume of 671 pages and furnishes a complete index to the work of the experiment stations and of this Department since the Hatch Act went into effect, and, since about 1893, to the more important investigations of a similar character in foreign countries. It contains not far from 125,000 entries, arranged under fully 50,000 headings and subdivisions. The longest subject, Milk (including Milk Production), occupies nearly 11 double-column pages; Soils, 9½ pages; Corn, 8 pages; Wheat, 7 pages; Cows, 6 pages, and Butter and Cheese, 4 pages each.

The first edition of 1,000 copies of this index was hardly more than sufficient to supply the college and station libraries and the heads of departments in the stations. A small reprint will be necessary to supply those for whom it was primarily intended and the considerable number of individuals who are making application for it. It is naturally of little value except to those who have a complete file of the Record, but its issue has served to show that an unexpectedly large number of private individuals have preserved the volumes of the Record, so that they have a complete set of the earlier volumes, or nearly so. One natural result of the general index has been to increase the demand for odd numbers to complete files, but the number of the earlier issues on hand is so small that very little assistance can be given in this connection except to libraries.

The expressions of appreciation of this general index which have come from those who have received it, have been very gratifying and serve to show its usefulness as an aid in looking up the literature of agricultural science.

EXPERIMENT STATION WORK.

This series of bulletins, which gives popular summaries of some of the more important practical results of experiment station work, attempts to do for the practical farmer what the Experiment Station Record does for the investigator and technical reader. Mr. W. H. Beal has the general editorial management of this series, the articles for which are prepared by the members of the editorial staff of the Experiment Station Record. The bulletins have been issued first in large editions in the regular series of Farmers' Bulletins of the Department, and afterwards in smaller editions with consecutive pages, so that they may be bound, with index, table of contents, etc., in convenient form for reference. The abundant supply of valuable material available for the preparation of these bulletins makes it desirable to issue them more frequently hereafter, and in order that the information they contain may be timely, it is hoped that the bulletins may be issued promptly at stated intervals, the topics for discussion being selected with reference to the needs of the readers at the time of issue of the bulletins. An effort is now being made to issue them at intervals of approximately two months. Twenty-six numbers have been issued in large editions since the series began, the demand for the bulletins making numerous reprints necessary. They contain a large amount of carefully compiled information on a great variety of agricultural topics, which, it is believed, has more than a temporary value. Three numbers were issued during the past year and the fourth was prepared for the printer. The nature of the contents of these bulletins is shown by the following list of subjects treated in the last four numbers:

No. 23.—Losses in manure, macaroni wheats, sterilizing greenhouse soils, tomatoes under glass, laying down peach trees for protection of buds, dandelions in lawns, apple pomace for milch cows, rations for laying hens, producing early molting in hens, control of evaporation from incubator eggs, the keeping quality of butter, and curing cheese in cold storage.

No. 24.—Cost of producing eggs in winter, combating the chicken mite, a succession of soiling crops for dairy cows, profitable and unprofitable cows, methods of milking, coating cheese with paraffin, the octagonal silo, ventilation of stables, and disposal of bodies of animals dying of contagious diseases.

No. 25.—Watermelons in the North, watermelon culture in Georgia, muskmelon culture in the North, Rocky Ford muskmelons, cold storage of fruits, selection of seed corn, bread and toast, cooking meat, and bitter milk.

No. 26.—Reclamation of flood-damaged lands, mulching vegetables and fruits, the cultivation of orchards, thinning of apples, popcorn, fruit for farm animals, home-grown *v.* purchased protein for dairy cows, cost of raising calves and pigs from birth to maturity, manufacture of sage cheese, manufacture of cottage cheese, and a cheap fruit evaporator.

BIMONTHLY LIST OF STATION PUBLICATIONS.

To still further aid in the dissemination of information regarding the literature of agricultural investigation, the Office has undertaken during the past year to issue a bimonthly list of the publications of the agricultural experiment stations in the United States similar to the monthly list of Department publications. These have been printed in limited edition and sent mainly to experiment station officials, farmers' institute workers, and others especially interested in keeping track of station publications. Four numbers have been issued to date, the first on January 1, 1904.

NUTRITION PUBLICATIONS.

The publications relating to the food and nutrition of man issued by the Office during the year are noted on page 500. These consisted of 5 technical bulletins, 1 Farmers' Bulletin, and 2 miscellaneous articles.

IRRIGATION AND DRAINAGE PUBLICATIONS.

The publications of the Office on irrigation and drainage are noted on page 519. They include 5 technical bulletins and reports, 1 Farmers' Bulletin, 3 circulars, and miscellaneous articles.

MISCELLANEOUS PUBLICATIONS.

The miscellaneous publications of the Office consist chiefly of (1) technical bulletins and reports, and (2) Farmers' Bulletins, including the series known as Experiment Station Work. The editorial work involved in the preparation of these publications for submission to the Division of Publications constitutes the special business of the editorial division of this Office, of which Mr. W. H. Beal is chief, although the general supervision of all other editorial work of the Office except that directly related to the Experiment Station Record is intrusted to this division. In addition to its regular business, this division has done a large amount of work connected with the preparation and printing of about 6,000 labels and 200 charts for the exhibit of the agricultural colleges and experiment stations at the St. Louis Exposition.

TECHNICAL BULLETINS.

Instruction in Agronomy at Some Agricultural Colleges, by A. C. True and D. J. Crosby (Bulletin No. 127, pp. 85, pls. 17, figs. 22), contains a brief review of the work of the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations, with extracts from the reports of that committee, and detailed descriptions of the courses in agronomy in the agricultural colleges in Alabama, Illinois, Michigan, Minnesota, Nebraska, and Ohio, and the agricultural institute of the University of Göttingen, Germany.

Legislation Relating to Farmers' Institutes in the United States and the Province of Ontario, Canada, by J. Hamilton. (Bulletin No. 135, pp. 53.)

Organization Lists of the Agricultural Colleges and Experiment Stations in the United States (Bulletin No. 137, pp. 100) contains the staff of the Office of Experiment Stations; lists of officers of the Association of American Agricultural Colleges and Experiment Stations, Association of Official Agricultural Chemists of the United States, Association of Economic Entomologists, and American Association of Farmers' Institute Workers, and a list of agricultural colleges and experiment stations in the United States, with governing boards, courses of study, boards of instruction, and station staffs. The bulletin also contains a complete index of names.

Proceedings of the Eighth Annual Meeting of the American Association of Farmers' Institute Workers, held at Toronto, Ontario,

June 23–26, 1903, edited by W. H. Beal for the Office of Experiment Stations, and G. C. Creelman for the association. (Bulletin No. 138, pp. 119.)

Special and Short Courses in Agricultural Colleges, by D. J. Crosby (Bulletin No. 139, pp. 59), contains a summary of information on the special and short courses in agriculture and related subjects offered at the land-grant colleges, showing that of the 63 agricultural colleges and schools receiving funds from the National Government 44 have organized such courses. These courses are designed to meet the requirements of those preparing to enter a regular agricultural course, those desiring instruction in agricultural subjects, but not fully qualified for college work, those desiring instruction in some particular phase of agriculture, and teachers desiring to prepare themselves to give instruction in nature study and elementary agriculture. Brief statements are made concerning the date of opening, length, nature, admission requirements, and cost of attending these courses.

Proceedings of the Seventeenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington, D. C., November 17–19, 1903, edited by A. C. True and W. H. Beal for the Office of Experiment Stations, and H. C. White for the association. (Bulletin No. 142, pp. 196, dgms. 3).

REPORTS.

Report of the Director of the Office of Experiment Stations for 1903, by A. C. True (Annual Reports, U. S. Department of Agriculture, pp. 245–324), contains a summary of the work of the Office during the year.

Annual Report of the Office of Experiment Stations for the year ended June 30, 1903 (U. S. Department of Agriculture, Office of Experiment Stations Report, 1903, pp. 758, pls. 60), contains reports on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1903, including a review of the work of this Office; summarized accounts of the meetings of the Association of American Agricultural Colleges and Experiment Stations and the American Association of Farmers' Institute Workers held in 1903; a list of the publications issued by this Office and the experiment stations during the calendar year 1903; statistics of land-grant colleges and experiment stations; Federal legislation, regulations, and rulings affecting agricultural colleges and experiment stations; annual reports of the Alaska, Hawaii, and Porto Rico experiment stations; a review of irrigation investigations for 1903, and the following special articles: Nutrition Investigations at the Government Hospital for the Insane, Washington, D. C., by W. O. Atwater; A Summary of Recent American Work on Feeding Stuffs, by C. F. Langworthy; Experiment Station Work with Apples, by C. B. Smith; Progress in Agricultural Education, 1903, by A. C. True; Farmers' Institutes in the United States, by J. Hamilton; Development of the Text-book of Agriculture in North America, by L. H. Bailey; Agricultural Economics as a Subject of Study in the Agricultural College, by K. L. Butterfield, and Instruction in Agriculture in Land-grant Colleges and Schools for Colored Persons, by D. J. Crosby.

FARMERS' BULLETINS.

Experiment Station Work, XXIII, XXIV, and XXV (Farmers' Bulletins Nos. 186, pp. 32, figs. 9; 190, pp. 32, figs. 14; 193, pp. 32, figs. 9). The character of this series and the contents of these numbers have been explained on page 478.

Barnyard Manure, by W. H. Beal (Farmers' Bulletin No. 192, pp. 32, figs. 4). A revision of Farmers' Bulletin No. 21, issued in 1894.

YEARBOOK ARTICLE.

Farmers' Institutes, by J. Hamilton (Yearbook of the Department of Agriculture, 1903, pp. 149–158). This article treats in a general way of the development and present status of the farmers' institute movement in the United States.

CIRCULARS.

List of State Directors of Farmers' Institutes and Farmers' Institute Lecturers of the United States, by J. Hamilton. (Circular No. 51, pp. 23.)

A Few Good Books and Bulletins on Nature Study, School Gardening, and Elementary Agriculture for Common Schools, by D. J. Crosby. (Circular No. 52, pp. 4.)

Report of the Committee on Rural Engineering of the Association of American Agricultural Colleges and Experiment Stations, by W. E. Stone et al. (Circular No. 53, pp. 10.) This report, presented at the convention of the association held at Washington in November, 1903, reviews the present status of instruction and research in rural engineering in this country and points out the necessity for improvement along these lines. It recommends the creation of separate departments of rural engineering in the agricultural colleges and commends the efforts of the Secretary of Agriculture to extend work of this character in his Department.

Report of Committee on Indexing Agricultural Literature, by A. C. True et al. (Circular No. 54, pp. 2.) This report, which was presented to the Association of Agricultural Colleges and Experiment Stations at its convention held in Washington, D. C., in November, 1903, calls attention especially to the card catalogue and index and accession cards of the Library of this Department and to the combined index of the first twelve volumes of Experiment Station Record.

The Relation of the Natural Sciences to Agriculture in a Four-year College Course, by A. C. True et al. (Circular No. 55, pp. 15.) This is a report of the committee on methods of teaching agriculture of the Association of Agricultural Colleges and Experiment Stations presented at the meeting of the association in November, 1903. It outlines a course of study in which the natural sciences are so arranged as to furnish a basis for the training of agricultural experts rather than the training of specialists in such subjects as agricultural chemistry, vegetable pathology, etc.

Constitution of the Association of American Agricultural Colleges and Experiment Stations, as amended at the seventeenth annual convention of the association, Washington, D. C., November 17–19, 1903. (Circular No. 56, pp. 4.)

The miscellaneous documents prepared and submitted for publication but not printed before the end of the fiscal year include: Propagation and Marketing of Oranges in Porto Rico, by H. C. Henrickson (Porto Rico Bulletin No. 4, pp. 24, pls. 6, figs. 4—English and Spanish editions); Experiment Station Work, XXVI (Farmers' Bulletin No. 202, pp. 32, figs. 9); Rules and Apparatus for Seed Testing (Circular No. 34, revised, pp. 24, figs. 11); List of State Directors of Farmers' Institutes and Farmers' Institute Lecturers of the United States, by J. Hamilton (Circular No. 51, revised, pp. 30); Organization and Work of Agricultural Experiment Stations in the United States, by D. J. Crosby (Document No. 708, pp. 24); Farmers' Institutes in the United States, by J. Hamilton (Document No. 711, pp. 20). The last two pamphlets were published primarily for distribution at the St. Louis Exposition.

CARD INDEX.

Copy for 1,000 cards of the index of experiment station literature was prepared in the Office and forwarded to the Division of Publications during the year. This covers practically all of the station publications received by the Office during the year. Some of the earlier cards of which the supply has been nearly exhausted have been reprinted in order to meet the increasing demand for sets of this index. The number of index cards distributed has reached 24,600. The receipts from sales of the index during the year were $247.07.

BIBLIOGRAPHICAL WORK.

The Office is cooperating with the Library in the preparation of author and subject indexes, in card form, to the more important articles in the leading agricultural journals. Additions have been made to the bibliography of nitrogen assimilation and to the bibliography of the nutrition of man and animals, especially as related to the feeding of horses. A bibliography of the literature of plants poisonous to stock is also being prepared in the Office. As heretofore, a list of bibliographies relating to agriculture appearing during the year has been prepared for the report of the bibliographer of the Association of American Agricultural Colleges and Experiment Stations. From time to time the Office prepares lists of references along different lines for station workers, which service has been greatly appreciated. The compilation of ash analyses of American farm products has been practically completed. Nearly 5,000 analyses have been collected and calculated to a uniform basis, and averages have been computed.

The collection of station publications has been continued as heretofore, and additions have been made to the sets of Department and station publications at the Alaska, Hawaii, and Porto Rico stations. A large number of foreign publications of all kinds have been received as exchanges. Many duplicates of station and other publications were received, a considerable number of which were distributed to college and station libraries and officers.

Work for the Civil Service Commission.

The Director of this Office has continued to act as the general representative of the Department in matters relating to examinations held by the Civil Service Commission for technical and scientific

positions in the Department. The number of papers received from the Civil Service Commission, recorded in this Office, and rated by examiners in the Department during the year was about 900, as compared with 873 last year. Besides the regular examinations, 50 special examinations were held during the year, as compared with 47 last year.

Insular Stations.

During the fiscal year ended June 30, 1904, the several experiment stations operating under the supervision of this Office report considerable progress. Much pioneer work has been done at each station, and there is still a great deal to accomplish; yet at each place it has been possible to take up some specific problems for scientific investigation. At each station definite lines of work have been adopted which will be continued as prominent features. At the Alaska station the production of cereals, the introduction and development of varieties of field and garden crops suited to the climate, and the feeding and care of animals will be given especial attention. At the Hawaii station studies of soils, insect and fungus pests, grasses and forage plants, and the development of minor agricultural industries are being given special consideration. The staff of the Porto Rico station has begun the investigation and introduction of new and improved varieties of horticultural products, improved cultural methods, coffee cultivation and improvement, the study of life histories of injurious fungi and insects and means for their repression. At each station the investigation of some of the problems in animal husbandry has been begun in a small way, and the importance of this subject is fully recognized, but its rapid development is retarded by a lack of funds for the purchase of live stock, salaries of experts, etc. The necessary pioneer work of clearing, fencing, draining, irrigation ditches, etc., to bring the land under cultivation, urgent building operations, necessary apparatus and equipment, all continue to make serious inroads on the incomes of the stations. If additional funds could be provided whereby this could all be attended to at once, it could be much more economically done, and in the future it would be possible for the station staffs to concentrate their efforts upon problems pressing for attention.

For reasons of economy the financial aid formerly given the Porto Rico and Hawaii stations by the insular legislatures was withdrawn in the one case and greatly reduced in the other. The falling off of the revenues of these islands has been so marked that there were not sufficient funds to supply all the needs of the local governments, and the stations were made to feel the necessity for retrenchment. It is unfortunate that this local support has been lost. The stations are for the benefit of the agriculture of the islands, and even a small appropriation from the insular funds would serve to bring the stations and the interests and industries of the islands into closer relationships.

A year ago, at the direction of the Secretary of Agriculture, plans were formulated by the different stations for cooperation with some of the scientific Bureaus and Divisions of this Department. Some of these plans have been put into effect in a manner that is very promising of good results, but there is room for still greater cooperation along the lines already begun, as well as in others not yet inaugurated.

The cooperation of the Section of Seed and Plant Introduction of the Bureau of Plant Industry has been of inestimable benefit to the stations through the generous supplies of seeds and plants furnished for experimental purposes. The facilities of that section for obtaining new and valuable varieties of field and garden products are unexcelled, and the stations furnish opportunities for their testing that are not to be found elsewhere in our country. The other Offices, Bureaus, and Divisions of the Department have aided the stations in many ways, and acknowledgments are made to them for their assistance.

As the work of the insular stations develops, the business of the Washington office in promoting their interests, arranging cooperative enterprises, editing publications, etc., increases. As hitherto, this business has been in charge of Dr. Walter H. Evans.

ALASKA STATIONS.

The work at the Alaska stations, in charge of Prof. C. C. Georgeson, during the past year has been successful, especially at the Copper River Valley station and at the Rampart station. At the Copper River Valley station many varieties of barley and oats matured perfectly, and at the Rampart station, where only a small plat of ground was cultivated, barley, oats, and spring wheat matured, though the growth was short. At the Sitka station oats, barley, and buckwheat matured. At the Kenai station and in the cooperative work with Mr. C. P. Coe on Wood Island grain did not mature during the past season. Vegetables did exceedingly well at all the stations, particularly at Sitka.

Sitka station.—The headquarters building has been completed in accordance with the plans furnished by this Department, except for some minor alterations made in the interests of economy. A hot-water heating plant was installed at a moderate cost. Bookcases, a supply case, tables, and chairs are still needed. As soon as it is practicable to add a chemist to the station staff one of the rooms in the headquarters building should be equipped as a laboratory. A frost-proof cellar was built for storage of those things which must be protected from freezing. A cow and some chickens were added to the live stock, and the station at present owns a yoke of work oxen, a 2-year-old steer intended for work, a cow, and a fine heifer calf. A small propagating house is under construction. It is planned also to build a chicken house and to secure chickens of representative breeds, with a view to comparing them as to their adaptability to the Alaskan climate. More attention will hereafter be given to horticulture and to the propagation of trees and bushes for distribution to other stations and over the Territory at large. Several varieties of early maturing potatoes have been procured and planted. Some nursery stock, consisting of hardy and early maturing varieties of apples, plums, and cherries, was purchased and planted. Currants, gooseberries, and raspberries are also being propagated. Three thousand apple seedlings raised from selected hardy varieties were obtained from the Minnesota Experiment Station last spring.

Kenai station.—At the Kenai station Mr. H. P. Neilson, who has been in charge of the station since its beginning in the spring of 1899,

resigned November 1, 1903. His place was taken by Mr. P. H. Ross, B. S., a graduate of the Kansas Agricultural College. Sixteen acres were under cultivation last year at this station and 5 more were cleared and broken, so that during the summer of 1904 about 21 acres were under cultivation. Grain did not mature at Kenai in 1903. Continued wet and cloudy weather produced an enormous growth, but the grain did not ripen. Our experience has led to the conclusion that it would probably be wisest to devote more attention to live stock at this station. An abundance of feed can be grown every year. Cattle do well, but grain is uncertain. With this end in view we have gradually added to the live stock, the station now having 3 work oxen, 4 cows (all of which are fair milkers), and 3 calves. The cultivated ground has been sown to grain as before, but it is expected that the crop will be mainly used for feed. Hardy vegetables are likewise planted. It is planned to increase the cultivated area to about 30 acres next year, and to install a small dairy equipment at the station next spring; to add a few more cows, and to operate an experimental dairy, the first of its kind in Alaska. There will be no local demand for the product of such a dairy, but it can be readily disposed of in the settlements along the coast.

Copper River Valley station.—The results so far obtained from the Copper River Valley station have been most encouraging. Between 9 and 10 acres were cleared and broken in 1902, and the first crop raised last year. Nearly everything matured and did well. As is always the case on new ground the growth was not vigorous, but the grain was plump, heavy, and perfectly matured. Spring wheat failed to mature, but nearly a dozen varieties of barley and oats produced remarkably fine grain. Cultivated grasses seeded in experimental plats did well, as did all the hardy vegetables. It is planned to clear 25 or 30 acres at this station, so that next year we shall have a genuine farm in the Copper River Valley. A log house for the superintendent has been completed, and a frost-proof sod house in which to winter potatoes and root crops will be built. There is no live stock at this station except a team of horses. For the present it is proposed to make the work of this station chiefly a test of the possibilities of grain growing in this region. Only such buildings as are absolutely necessary for shelter will be erected on the present site until the question of permanent location can be settled. This station has the first equipment of farm implements brought into the interior of Alaska, and as yet it is the only inland place where farming is carried on on anything like an extensive scale. A number of small tracts have been cleared by settlers and are under cultivation at various points throughout the valley.

Rampart station.—Only a small amount of work was done at the Rampart station during the past year. Grain matured as it did the year before, and this has encouraged us to undertake more extensive experiments. An equipment of implements has been procured, and Mr. F. E. Rader, who has been assistant at the Sitka station since the spring of 1900, has taken charge of the work.

The cooperative work on Wood Island is being continued. It is confined, however, to the growing of vegetables and testing of grains and grasses. Thus far grains have not matured well, but it is proved that they can be grown so as to yield an abundance of cattle feed.

These experiments cost the station but little aside from the seed which is furnished.

Seeds of vegetables and flowers were distributed through the cooperation of the Bureau of Plant Industry to about 1,500 addresses. Many of the recipients report their successes and further confirm the possibility of raising hardy vegetables and hardy annual flowers in nearly all parts of the Territory south of the Arctic Circle. The distribution of seed should be continued, and cooperative arrangements made with the Bureau of Plant Industry to furnish seeds required for introduction into Alaska. This country is still in a pioneer state, and there are no seed dealers in the Territory. By supplying the people with small quantities of seed of hardy garden vegetables it is made possible for many settlers to have gardens, the lack of which would in many instances prove a hardship.

An investigation of the grasses and forage plants of Alaska is being conducted in connection with the Bureau of Plant Industry of this Department, the Agrostologist having sent one of his assistants to spend the summer season in southern Alaska. Investigations in cooperation with other bureaus of the Department are very desirable, and should be arranged as soon as possible. These are particularly desired along entomological lines and soil studies. The Alaska stations are particularly indebted to the Bureau of Plant Industry for seed imported from high latitudes of Europe, some of the varieties proving of exceptional merit. Of especial note are the Sixty-day and Finnish Black oats, the latter growing well and ripening a fine quality of grain at Rampart, at latitude 65° 30′.

The special agent in charge again calls attention to the desirability of securing breeds of sheep and cattle better adapted to the climate of Alaska. He thinks that the Black-faced Scotch sheep and Galloway and West Highland cattle would be adapted to the conditions of the region, and that an appropriation for the purpose of introducing these breeds would be of permanent benefit to the people of the Territory.

HAWAII EXPERIMENT STATION.

The work of the Hawaii Agricultural Experiment Station, in charge of Mr. Jared G. Smith, has been conducted in continuation of the various lines of investigation described in previous reports. Considerable work has been done toward bringing portions of the station grounds under cultivation and in the erection and repair of buildings, fences, etc. A new insectary 12 feet 6 inches by 25 feet, with glass sides and roof, concrete floor, benches, breeding cages, and water fixtures, was built adjacent to the entomologist's laboratory, and two small cottages for laborers and an addition to one of the stables were also built. In June, 1904, contracts were let for the construction of a residence for the chemist, for which the Territorial legislature made an appropriation of $1,500. The station water system has been improved, giving a more abundant supply of water and doing away with the necessity of pumping, but there is still need for a larger supply of water for experimental purposes than can be afforded from the water system of the city of Honolulu. The residences of the director and farm foreman have been repaired and painted. A telephone line has been built connecting the main buildings with each other and with the city system. Four acres of land

surrounding the main office have been placed in first-class condition and will be used for plat experiments. About 15 additional acres of pasture land have been fenced and cleared of guava and lantana. A considerable number of books were added to the library during 1904, mainly standard works on entomology and chemistry. Many American agricultural publications are obtained by exchange for station publications, while a number of other periodicals devoted to practical agriculture are subscribed for.

As stated in the annual report for 1903, the Territorial legislature appropriated $5,000 per year for two years for assistance to the station and $1,000 as part of the salary of the station chemist, but at a special session the legislature cut down the appropriation for the station to $2,730 and cut out the appropriation for the chemist's salary. This new law went into effect July 1, 1904, and has necessitated some modification in the plans of the station operations as previously determined upon. The Territorial assistance given the station is apportioned to various purposes by the board of commissioners of agriculture and forestry, acting on recommendations made by the special agent in charge of the station. About one-half of the fund now available has been set aside for carrying on a tobacco experiment at Pohakea, Hamakua, on the island of Hawaii. At this place a tract of land has been leased for a number of years and experiments are under way with Sumatra and Habana tobaccos, grown under cotton-cloth shade and in the open. It is expected to continue these experiments for a number of years, and it is hoped that a type of tobacco will be discovered that is adapted to Hawaiian conditions and that it will be possible to develop the growing of tobacco as a profitable industry.

Cooperative experiments in cacao cultivation are also being carried on in connection with the board of agriculture and the Hilo boarding school. The station had on hand a large number of cacao seedlings, and an arrangement has been effected by which the growing of this crop is to be investigated through a period running from seven to eight years. In connection with this cooperative experiment, investigations will be carried on upon the selection, propagation, and cultivation of bananas. During the past fiscal year arrangements were perfected whereby several hundred banana plants were obtained from Costa Rica, Central America, for planting in Hawaii. These were secured through the United Fruit Company, the only expense attached being that of transportation. The plants were received in Hawaii, fumigated, and turned over to the station for cultivation, the desire being to establish in the island a type of banana which will bear shipping better than that now produced for the export trade. It is believed by many that the Bluefields or Central American banana is superior to the Hawaiian varieties in shipping and keeping qualities, and it is only through the receipt of a large number of plants that this matter could be definitely settled in a comparatively short time. These plants were obtained in cooperation between the station, the board of agriculture, and this Department.

The chemist of the station, who was appointed after the beginning of the present fiscal year, has been compelled to work with very incomplete facilities. A room in the office building, originally used as the kitchen and pantry of the house, was fitted with shelving and tables and used for a laboratory. A gas machine was purchased,

together with a limited amount of glassware and other apparatus. The chemist has been devoting his time entirely to research investigation, and is studying the composition of some of the organic compounds in the soil. He has discovered pyridine compounds in the humus of the soil that have been hitherto suspected but not isolated. These are important nitrogenous compounds, and his discoveries in this line are not only of scientific interest, but of economic importance.

The horticulturist of the station, who was appointed in October of 1903, has prepared for publication a bulletin on bananas, which will soon be issued. This bulletin not only treats of the cultivation and marketing of bananas, but brings together descriptions of a large number of Hawaiian varieties, making it possible to make a systematic study of this important food plant. Experiments are being continued on the cultivation and fertilization of bananas and a large collection of varieties is being brought together on the station grounds. The horticulturist has begun experiments with the propagation of mangoes and alligator pears, investigating the possibility of the propagation of the more desirable varieties by means of budding, etc. He also has charge of the experiments with small fruits and vegetables, and as secretary of the farmers' institute, which is fostered by the station, has done much valuable educational work. He also collected and prepared a large exhibit of fruits and horticultural products for the Louisiana Purchase Exposition, which was exhibited as a part of the exhibit of this Office in the Government Building.

The entomologist prepared a bulletin on the leaf hopper of the cane, which has recently been issued. This investigation was made at the solicitation of many of the planters of the islands. This insect made its appearance quite recently, and has proved in certain districts to be a very serious enemy to cane cultivation. The bulletin treats of the life history of the pest, describes the injury produced, and offers suggestions for its control. In connection with this investigation the entomologist visited plantations on the various islands, and he has also investigated a number of other insect enemies of field and garden crops. Investigations have been carried on in the use of insecticides and other methods of control of injurious insects.

The special agent in charge of the station, in addition to attending to the business of the station as director and disbursing agent, has been investigating some of the fungus diseases of coffee, cane, and other economic plants; has begun a comparative test of grasses and forage plants in connection with the Hawaii Live Stock Breeders' Association, and has continued the direction of the farmers' institute work.

The farmers' institutes in Hawaii were organized through the efforts of the special agent and other officers of the station and have proved of great value in bringing together individuals interested in agriculture and in securing the results of each other's practical experience. The value of this work was recognized by the legislature, which in regular session appropriated $600 for aiding in carrying on the work. This appropriation, however, was cut off at the special session in its recent meeting.

An attempt is being made by the special agent to bring together the coffee growers of the Hawaiian Islands into an association for their mutual advantage. In this connection letters were addressed

through the Department of State to a number of the American consuls in Europe asking for samples and prices of the different grades of coffee that are comparable with the Hawaiian product. With this as a basis it is believed that something can be done toward developing a market for the superior grades of Hawaiian coffee.

For the fiscal year 1905 the work planned is along the lines previously indicated. The chemist will continue the investigation of the chemical composition of some of the Hawaiian soils, paying particular attention to the elaboration of methods for the determination of some of the pyridine compounds. In addition, the analysis of forage plants has been begun, which will be in connection with the investigation of forage plants and range conditions by the special agent. The special agent expects to publish a bulletin on the grasses and forage plants of the Hawaiian Islands during the coming year and also on wattle bark for tanning. There are on the station grounds some 5 acres of 13-year-old wattle trees, which were introduced from Australia and which are now about mature and should be marketed. An estimate has been made of the product and it is believed that the trees will yield 9 tons of bark and 40 cords of wood per acre. If the investigation proves a successful one and a market is established for this important tanning material, it is possible that a new industry may be developed, as the trees grow rapidly and produce abundantly.

The tobacco cooperative experiments will be continued, and an attempt will be made to grow a considerable area of cotton to see whether this industry can be established on a commercial scale.

The black rot of cabbage and a number of other fungus diseases are being investigated and will be reported upon when sufficient data are at hand.

The entomologist will continue the studies of the life histories of some of the more injurious insects in Hawaii, and in connection with the board of health and department of public works will continue the work of ridding Honolulu of mosquitoes. In this connection a bulletin describing the mosquitoes of Hawaii and giving studies of their life history has been recently issued.

The horticulturist will continue work on bananas, mangoes, alligator pears, pineapples, and other tropical fruits, and will prepare bulletins upon some of them during the year.

Since the last report Bulletin No. 5, The Sugar-cane Leaf Hopper, and Bulletin No. 6, Mosquitoes in Hawaii, have been issued, and the demand for earlier bulletins has required the reprinting of Bulletins 3 and 4, Insecticides for Use in Hawaii, and The Cultivation of Sisal. In addition to the regular series of bulletins, press bulletins have been issued as follows:

Press Bulletin No. 6.—Vanilla Cultivation in Hawaii.

Press Bulletin No. 7.—Mosquitoes (five editions, in English, Hawaiian, Portuguese, Chinese, and Japanese, and a reprint of the same, paid for by the board of health).

Press Bulletin No. 8.—The Mealy Bug or "Pear Blight" of the Alligator Pear.

Press Bulletin No. 9.—Two Plant Diseases in Hawaii: Pineapple Disease of Sugar-cane and the Brown-eyed Disease of Coffee.

PORTO RICO EXPERIMENT STATION.

The work of the Porto Rico Experiment Station, in charge of D. W. May, has been vigorously pushed along the lines laid down in the last annual report. The weather conditions for the year were as a whole very favorable to crop production. Both the rainfall and temperature were about normal, the rainfall being well distributed, there being less drought during January, February, and March than usual. The administrative work has greatly increased in all directions, and letters of inquiry and requests for information were considerably greater than in previous years.

The Federal appropriation for the year ended June 30, 1904, was $15,000, whereas for preceding years it had only been $12,000. This was increased by an appropriation of $2,700 made by the insular legislature and nearly $1,200 received from the sale of farm products. As a result of this increase in funds one permanent and one temporary addition were made to the station staff and the work was considerably increased. A portion of the insular appropriation was made for permanent improvements, and more than 500 rods of woven-wire fence was purchased and erected. The new fence, with iron gates and lockers, prevents trespassing by animals, which are allowed to run at large, and also adds greatly to the appearance of the farm. A small tile machine was purchased and drain pipes were manufactured on the farm for the purpose of underdrainage. The sizes ranged from 3 to 8 inches, and where a larger capacity was required two or more lines were placed side by side. Practically all of the river-bottom or alluvial land on the station farm has been put under drain. This is the first underdrainage ever undertaken in Porto Rico, and it is believed that it will not only greatly enchance the producing power of this land, but will serve as a valuable object lesson to the planters of the island. In cooperation with the Office of Experiment Stations, a dam has been constructed and ditches excavated for an experimental irrigation system. The residence, office, and laboratory buildings, and one of the tool houses were painted. It is believed advisable that all farm buildings at the station should be painted at least once a year. Where proper attention is not given to painting, white ants and wood borers get into the structure and very soon destroy it.

Five hundred dollars were appropriated from the insular funds for special investigations on tobacco. A tobacco specialist was employed, who spent three months in making a preliminary survey of the principal tobacco districts of the island. As a result of these preliminary investigations it was deemed desirable to take up some experimental work with tobacco from a practical standpoint. The service of this specialist was secured for the remainder of the fiscal year, to be paid out of the Federal appropriation. These preliminary experiments have been concluded and a report upon them is in progress of preparation and will be issued as a bulletin of the station during the coming year.

An equal sum from the insular appropriation was devoted to coffee investigations. This was added to the allowance that had been previously set aside from the Federal appropriation and permitted of some extension of the investigations along this line. In addition to the work which has been previously outlined in former reports, an experiment was undertaken to ascertain the practicability of exter-

minating the coffee-leaf miner by hand picking the leaves. The removal of all infested leaves was made at intervals of two weeks extending over a period of nearly three months. The tract used for this purpose was about 1 acre in extent and was situated some distance from any other coffee. There were slightly more than 1,000 trees upon the area and the number of leaves removed at each picking was ascertained. The task of removing the infected leaves proved to be so stupendous that it is considered impracticable as a method of extermination. The entomologist has been investigating the possibility of combating the coffee-leaf miner by means of parasites, and reports the discovery of an effective parasite which he believes by careful propagation and distribution will aid very materially in keeping in check this insect pest, which is by far the most serious enemy to coffee cultivation now upon the island.

In the spring of this year Dr. G. P. Clinton, botanist of the Connecticut State Experiment Station, visited the island to make a study of some of the conditions relating to plant diseases of the island. He spent a number of weeks at the station and has reported upon the conditions as observed by him, particular attention being paid to some of the diseases of coffee.

Since the last report of this station many additions have been made to the collections of tropical fruits. Particular attention is being given to the propagation of citrus fruits, with the idea of obtaining better stock for growing in the orchards of Porto Rico. Nearly all the citrus nursery stock on hand has been budded with various varieties, and an orchard has been planted which contains between 30 and 40 varieties of oranges, lemons, and grape fruits. The banana plantation has been extended and now contains over 50 varieties. At the present time a number of the first-planted varieties are in fruit. A pineapple plantation containing 6 varieties has been planted and is doing very well. A large number of miscellaneous tropical fruits, including the mango, aguacate or alligator pear, soursop, nispero, guava, and many others have been brought together in a tropical fruit orchard.

The tea, rubber, and cacao plantations mentioned in the last report are flourishing, and efforts are being made to continue and extend them. Among the tropical vegetables which enter into the variety tests may be mentioned the yautia, malanga or taro, edible canna, arrowroot, cassava, yams, and sweet potatoes. All of these have done well, and in some instances the yautia, canna, and cassava have yielded at the rate of 12 to 15 tons of roots per acre. Experiments are being carried on with a number of fiber plants, among them the Manila hemp, maguey, sansevieria, coquisa, sisal, and Indian madar. The Manila hemp has grown slowly, and its success in Porto Rico is problematic. The maguey, sisal, and sansevieria do well, and the first two are very promising as fiber-producing plants. The station has conducted no careful experiments with cotton, but the industry has been extended throughout the island to a considerable extent during the past year, and the results seem to indicate that it is possible to profitably produce a medium grade of Sea Island cotton in Porto Rico.

A number of complaints having been received from orange planters in regard to the depredations caused in their groves by a small brown

ant led to investigations by the entomologist relative to its control. This ant, which lives in small colonies in the ground about the roots of the trees, frequently attacks the bark of the trees just above the ground, in many instances completely girdling them. It also passes up the trunk into the branches and frequently eats the new buds. As a result of the investigations, the use of a girdle paint is recommended, which not only prevents the ants from further girdling the trees, but assists the wounds in healing. Another form of paint was tested, which when placed in bands about the trees prevents the passage of the ants up into the trees.

Owing to a lack of funds little has been attempted in live-stock experiments. Three good mules were obtained during the year by purchase, which, together with the one already at the station, makes two very good teams. These, in addition to a yoke of work oxen and a horse or two, comprise the equipment of the station as far as animals are concerned.

Among some of the lines of investigation which it is hoped to develop during the coming fiscal year are experiments with live stock; feeding value of tropical plants, such as cassava, native and introduced grasses, etc.; rice growing under irrigation; tests of varieties of Indian corn suitable to Porto Rico conditions; winter production of potatoes; fertilizer experiments in citrus orchards; study of soils and fertilizers for pineapples, and investigation of fungus and insect enemies of economic plants.

On May 1, 1904, Mr. D. W. May was appointed special agent in charge of the Porto Rico Experiment Station to relieve Mr. Frank D. Gardner, who desired to return to this Department to resume his former connection with the Bureau of Soils. In this connection I wish to express my appreciation to Mr. Gardner for his earnest and valuable services in the pioneer work of establishing and developing the experiment station in Porto Rico. Mr. Gardner spent nearly three years in Porto Rico, first at temporary headquarters at Rio Piedras, and later at Mayaguez. His work was well planned and as successfully carried out as limitations of pioneer work and modest appropriations made it possible.

The organization of the station staff consisted, during the year, of the special agent in charge, the botanist and entomologist, coffee expert, horticulturist, a farm superintendent, and a clerk and stenographer. During the fiscal year English and Spanish editions were issued of Circulars No. 1 on Sansevieria, No. 2 on Cotton Growing in Porto Rico, No. 3 on Soil Survey from Arecibo to Ponce, and a fourth circular on Coffee Growing in Porto Rico is in course of preparation. Buletin No. 4, entitled Probagation and Marketing of Oranges in Porto Rico, has just been issued, while the results of tobacco investigations are being prepared as Bulletin 5 of the regular series.

Nutrition Investigations.

The inquiry regarding the food and nutrition of man, which is carried on under the auspices of the Office, has been continued through the fiscal year ending June 30, 1904, on very much the same lines as in previous years, and, as hitherto, these investigations have been in charge of Prof. W. O. Atwater.

The cooperative method, by which the work of investigation has been distributed among various educational, scientific, and similar institutions in the United States, has been productive of as excellent results the past year as hitherto, and a satisfactory amount of investigation has been conducted. This has been made possible by the generous support accorded by the cooperating institutions, which have contributed in some cases money and in practically all cases the use of laboratories, apparatus, libraries, the advice and counsel of skilled experts, and similar assistance. Other institutions have expressed a readiness to join in such researches, provided a comparatively small amount can be allotted them, but with the funds at our command it has not been found possible to extend the inquiry beyond the present limits.

OBJECT AND NATURE OF THE INQUIRY.

In these investigations attention is devoted mainly to the physiology, hygiene, and economics of nutrition. Chemical work is confined as closely as possible to that necessarily involved in the different inquiries. The chief object of the inquiry is to discover the fundamental laws of nutrition and their economic and sociological application to the health and well-being of mankind.

In the prosecution of the inquiry during the past year attention has been devoted more particularly to cooking experiments, dietary studies, digestion experiments, and investigations with the respiration calorimeter on the transformations of matter and energy in the human body.

The object of the cooking experiments is to study the changes and losses resulting from the different methods of cooking and the effects of cooking upon digestibility and nutritive value. During the past year these experiments have been made only with meat, and principally with beef.

The purpose of the dietary studies is to secure information regarding the kinds, amounts, and cost of food materials used by people under widely varying conditions in different parts of the country, to furnish data for comparison with the results of similar investigations in this and other countries, and to assist in establishing general dietary standards.

The digestion experiments have for their purpose the securing of data regarding the digestibility of different classes of food materials—i. e., the amount of consumed material which is actually made use of by the body and the establishment of standard factors or coefficients of digestibility. The special classes of food materials studied during the past year were legumes, cereals, fruits, and nuts. The digestion experiments with cereals were made with various cereal foods and with macaroni and bread from flour milled from American-grown macaroni wheat.

The investigations with the respiration calorimeter have included experiments with men in which the income and outgo of nitrogen, carbon, hydrogen, oxygen, and energy were determined. An important feature of some of the experiments during the year was the study of the relative value of fats and carbohydrates as sources of energy for muscular work.

All the investigations have necessarily included more or less analytical work, both physical and chemical; and, as in the past, attention

has been devoted to the improvement of apparatus and methods of inquiry. In addition, a large amount of editorial work is required, at both Washington and Middletown, to prepare the results of investigation for publication in technical and popular form; and this involves calculations and verifications of data, which require time and labor, but which are necessary for the accuracy essential to all scientific inquiry.

WORK AT THE WASHINGTON OFFICE.

The Washington office, in addition to editoral work, has had a general supervision of the plans and expenditures of the nutrition investigations during the past year. The results of such inquiry in this country and in Europe, not generally available, and bibliographical data have been collected, and the current literature on the subject of nutrition has been reviewed and abstracts made, partly for use in the Experiment Station Record and partly for such other purposes in connection with the general inquiry as seemed desirable. The growing interest in the nutrition investigations carried on under the auspices of the Department is indicated by the constant increase of correspondence in this connection. This correspondence, and also the distribution of the nutrition publications, is attended to at the Washington office.

COOPERATING INSTITUTIONS AND INVESTIGATORS.

The institutions at which the cooperative investigations have been conducted during the past year, and the various investigators, were as follows:

California: University of California; Prof. M. E. Jaffa and associates.
Connecticut: Wesleyan University and Storrs Agricultural Experiment Station; Prof. W. O. Atwater and associates.
District of Columbia: Government Hospital for the Insane; Dr. W. A. White and H. A. Pratt.
Illinois: University of Illinois; Prof. H. S. Grindley and associates.
Maine: University of Maine; Prof. C. D. Woods and associates.
Minnesota: University of Minnesota; Prof. Harry Snyder and associates.
New York: Columbia University; Dr. H. C. Sherman.
Tennessee: University of Tennessee; Prof. C. E. Wait and associates.

THE COOPERATIVE INVESTIGATIONS.

Much of the cooperative investigations carried out the past year have been in continuation of those of previous years, partly for the reason that in some cases the work of successive years forms a regular series, and partly because in all work of this character it is necessary to verify and corroborate results by repetition. On the other hand, work along new lines has also been undertaken. The cooperative investigations for the year in the several States follow:

CALIFORNIA.

The nutrition investigations at the University of California, conducted by Prof. M. E. Jaffa and his associates during the past year, form part of a series intended to cover two years. The digestibility of fruit and nuts and their value when forming part of a mixed diet was the general subject under investigation. The nutritive value

of a diet consisting almost wholly of fruit and vegetables was also studied. The investigations included 35 digestion experiments with subjects living on a mixed diet of which fruit and nuts formed a considerable part, these experiments including the determination of the income and outgo of nitrogen, and 4 dietary studies with subjects living chiefly on fruits and vegetables. In connection with these investigations, analyses were made of 40 samples of food materials and of 190 samples of excretory products.

Professor Jaffa has had unusual facilities for carrying out investigations of this nature, and was able to obtain especially good subjects for the experiments. Fruit and nuts may be made a very useful part of the diet, but, aside from the work already undertaken by Professor Jaffa, comparatively little attention has been given to the study of their nutritive value by investigators. California furnishes such an abundant variety of both fruit and nuts that the conditions for such investigations are very favorable, and it is hoped that this inquiry will establish the dietetic value of these food materials and lead to their more general and intelligent use in American households.

Prof. Jaffa is as yet able to give only a progress report, since this series will not be completed until next year, but the results so far obtained agree with those of the investigations carried on in 1901–1903, a report of which was published in a recent bulletin.

CONNECTICUT.

The work at Middletown, Conn., under Prof. W. O. Atwater, chief of the nutrition investigations, has included the planning and direct supervision of the cooperative investigations throughout the country; the carrying out of special inquiries with the bomb and respiration calorimeters; improvements in apparatus and methods of inquiry; editorial work, including calculations and verification of data required in preparing the results of investigations for publication; the compiling of results of investigations in this and other countries on the food and nutrition of man; correspondence and general administrative work.

In addition to the amount set aside for work at Middletown under the auspices of the Department, $900 of a special appropriation made by the State of Connecticut to the Storrs Experiment Station has been placed in Professor Atwater's hands for nutrition investigations, which are carried out at Wesleyan University, under his supervision. Wesleyan University also contributes the use of its laboratories and other facilities for the same purpose.

It is also worthy of special note that the Carnegie Institution of Washington has given material assistance to research with the respiration calorimeter. The great desirability of a means for the direct determination of the amounts of oxygen used by men and animals for respiration and oxidation in the body had for a long time been very manifest. For the year 1903 the Carnegie Institution made a grant of $5,000 to Prof. W. O. Atwater for the development of apparatus for this purpose in connection with the respiration calorimeter in his laboratory. The effort proved very successful, and the grant was made $7,000 for 1904, to be used in experiments on the income and outgo of oxygen in the body.

INVESTIGATIONS WITH THE RESPIRATION CALORIMETER.—The work with the respiration calorimeter, under the direction of Professor Atwater and in the more immediate charge of Prof. F. G. Benedict, has been for much of the time devoted to the perfecting of the apparatus and methods. In this connection, the months of October and November were given almost wholly to a large number of tests with the respiration calorimeter to determine the best method for eliminating the temperature fluctuations in the calorimeter room, and to a series of electrical and alcohol check tests. A new water meter, for measuring the quantity of water that passes through the heat-absorbers in the respiration chamber, was also adjusted and carefully tested and calibrated.

As a result of experimenting in the latter part of 1903 and the early part of 1904, a number of changes in the details of the apparatus were made, which included the calibration of the elster meter, readjustment of the equipoises on the pans regulating the air supply, a valve for shutting off the air system near the pumps, a new pump for the circulating air current, and an improved closure for the food aperture.

One of the most valuable improvements the last year has been in the method of weighing the subject of the experiment while in the respiration chamber. Previously the man weighed himself on scales inside the chamber, but by the system instituted this year the weighing is done by an assistant outside. This method has proved very successful and accurate, and it is now possible to weigh the subject to within 2 or 3 grams. By introducing a slight modification the device may be used for weighing the absorber system, likewise with great accuracy.

The folding canvas bed previously used has been replaced by a steel and wire-mesh bed, fastened to the inner wall of the chamber. This can be folded up against the wall when not in use and is a decided improvement over the old form, as it occupies less room and is easier to handle.

The mercury switch, which has always proved so satisfactory when used with the thermal junction circuits, gave considerable trouble when the attempt was made to use it for the measurement of temperature by the "bridge" method. Careful testing showed the galvanometer to be at fault, and when this was repaired the "bridge" system for measurement of temperatures in the respiration calorimeter proved very satisfactory.

In connection with the analytical work of the experiments, not a little time has been devoted to testing the effect of the partial drying of samples in vacuo. For accurate work it seems to be necessary to dry at temperatures far below 100° C. The vacuum method seems at present to be the only one that is satisfactory. Indeed, when high vacuum is used the length of time required is not much greater than is needed when the samples are dried by heat in the ordinary method. A number of refinements in the manipulation of the food in sampling, also in determining the heat of combustion of urine, milk, and cream, have all contributed to much greater accuracy in the measurement of the income and outgo of energy in the metabolism experiments.

Actual experimental work with the respiration calorimeter during the year comprised 11 experiments with 3 different subjects, covering a total period of twenty days within the apparatus, one subject having remained in the chamber thirteen days and fourteen nights.

This period was divided into seven separate experiments, with varying amounts of food and exercise, from fasting and extreme quiet to abundant diet and unusually hard work. This was the longest period and the largest number of different experiments in an uninterrupted series yet attempted with one subject in these investigations, and, in view of the improvements in apparatus and methods mentioned above, is in many ways the most complete and satisfactory.

In addition to these complete metabolism experiments, a number of experiments of about twelve hours each were made with several subjects to determine the amounts of heat radiated from the body under different conditions of lying, sitting, standing, and operating the bicycle ergometer. It was the purpose to continue such experiments with varying amounts of clothing, to determine the effects of clothing upon the radiation of heat from the body, but there was no opportunity to do so during the past year. That the experiments carried out during the year should cover so long a period is very gratifying, in consideration of the fact that, contrary to what has previously been the case, considerable difficulty was experienced in finding a suitable subject, several different men having proved unsatisfactory.

Other experimental work.—Twenty-five digestion experiments were also carried on at Middletown during the year—9 experiments, on 5 different subjects, with cereal breakfast foods, and 16 experiments, on 4 subjects, with fish and poultry.

General work.—A considerable amount of editorial work is done at Middletown, including calculations, verifications of results obtained in cooperative investigations, the collating of results of other investigations, and the preparation for publication of the results of the experimental work at Middletown and at cooperating institutions. In connection with the work this year, an improved system of tabulating the results of dietary studies made in connection with the nutrition investigations has been adopted, which preserves the data in a more permanent form and makes them prove readily available for reference. The tabulation is not yet completed, but is being carried on as rapidly as pressure of other work will permit.

DISTRICT OF COLUMBIA.

The report of the dietary studies conducted in the fiscal year 1902–3 in Washington, in cooperation with the Government Hospital for the Insane, has been prepared for publication, the bulk of the work of calculation and editing connected with this report having been done at Middletown during the last fiscal year. At the hospital opportunity was also afforded by the superintendent, Dr. W. A. White, during the year for obtaining some additional statistics and information regarding the food supply, the details of the work being carried on as heretofore by H. A. Pratt.

ILLINOIS.

The investigations with meat, carried out at the University of Illinois by Prof. H. S. Grindley and his associates, have been continued the past year under most favorable conditions. In addition to the use of a new and well-equipped laboratory, the university has con-

tributed $2,000 toward the nutrition investigations. Furthermore the experiment station furnished, without charge, the meat used in the investigations. The animals from which the portions of meat were taken were bred, grown, and fed under known conditions, this being carried out under Professor Grindley's direction. The department of household science also rendered valuable assistance.

The investigations carried out the past year consisted of 58 experiments to study the losses and chemical changes resulting from the cooking of meat and the influence of different methods of cooking upon the nutritive value of meat (beef). These investigations included the complete analysis of 80 samples of uncooked and cooked meats, of 55 water extracts of samples of uncooked and cooked meats, and of 36 samples of broths. In addition, determinations have been made of proteids of different kinds in broths from cooked meats and in water extracts from uncooked meats.

A valuable feature of Professor Grindley's work the past year has been the very satisfactory improvement of the methods used for the nitrogen determinations.

MAINE.

The nutrition investigations at the University of Maine, carried on by Prof. C. D. Woods and associates, have had for their especial purpose the determination of the digestibility of different cereal breakfast foods. Thirty-four natural digestion experiments, of four days each, were conducted, including determinations of the metabolic products in the feces by two methods and 34 artificial digestion experiments of samples of the cereals used in the natural experiments. In connection with the investigations 100 complete analyses of foods and feces and about 200 partial analyses were made.

In addition to the experimental work, reports of the dietary studies and digestion experiments with lumbermen and of the digestion experiments with bread were prepared during the year.

MINNESOTA.

The nutrition investigations carried out at the University of Minnesota under Prof. Harry Snyder included the following: Twenty-five digestion experiments with men, of four days each, to determine the relative digestibility and nutritive value of certain cereal breakfast foods; 1 milling experiment with American-grown macaroni wheat; 1 experiment on the preparation of macaroni from the flour milled in the previous experiment; 6 digestion experiments with men, of four days each, for the purpose of studying the digestibility and nutritive value of flour and macaroni prepared in the preceding experiment, the flour being made into bread. In connection with these experiments 93 analyses were made of food and excretory products and 68 determinations of heats of combustion.

The investigations with cereal breakfast foods were along the same lines as those carried on by Professor Woods, at the University of Maine. The studies with macaroni wheat were in continuation of investigations on the nutritive value of different sorts of wheat previously carried out.

NEW YORK.

Dr. H. C. Sherman, of Columbia University, spent a month, in the summer of 1903, at Middletown, and took part in the cereal digestion experiments conducted at that time. During the past year he has also been collecting data from the published work of other investigators regarding the protection of proteids in the body. The collating of this material has not yet been completed, and will be continued another year.

TENNESSEE.

Prof. C. E. Wait, at the University of Tennessee, Knoxville, has continued the two lines of investigations of previous years, viz, dietary studies with white people of limited means living in the mountain districts, and digestion experiments. The details of the dietary studies with the mountain families were carried out by Prof. A. F. Gilman, under the supervision of Professor Wait. The investigations completed during the year are as follows: 20 dietary studies of fourteen days each in typical families of white people of limited means, especially those living in the mountain districts; 12 digestion experiments with men, of four days each, 6 with a basal ration, followed by 6 experiments in which legumes were substituted for a certain portion of the ration used in the basal ration experiments. In connection with the dietary studies, 20 analyses of wastes were made, and in the digestion experiments 9 analyses of food materials, 24 analyses of excretory products, and 33 determinations of heats of combustion.

MISCELLANEOUS.

European investigators are manifesting much interest in the nutrition investigations carried on by the Department of Agriculture. A large number of requests are made for the reports of the investigations, and appreciative references are published in various foreign journals.

A society for the study of the nutrition of man has lately been organized in France for the purpose of carrying on nutrition investigations similar to those of the Department of Agriculture.

During the past year Professor Atwater visited many of the leading universities and laboratories in Europe where investigations are being made with regard to the nutrition of man, meeting a large number of eminent investigators. One special purpose of his journey was to obtain information regarding the food of people of different classes in the different countries and the relation of their nutrition to their productive power and general welfare, and to find ways for best obtaining the results of European investigators along these lines. In this connection he visited France, Italy, Switzerland, Belgium, Germany, Austria-Hungary, and England. In Italy he was afforded the opportunity to visit the laboratory of Professor Mosso, on the summit of Monte Rosa.

In connection with the nutrition investigations, Professor Atwater has delivered several addresses at educational institutions and elsewhere. He has recently attended the meetings of the British Association for the Advancement of Science, at Cambridge, England, and

the International Physiological Congress, Brussels, Belgium, at both of which he gave addresses describing the nutrition work of this Department. This is one of the ways in which the results of the inquiry are made available to the general public, and the frequent requests for such addresses indicate the increasing recognition of the usefulness of such research.

FOOD AND NUTRITION PUBLICATIONS.

The food and nutrition publications issued the past year have included 5 technical bulletins, 1 Farmers' Bulletin, an article prepared for the Yearbook of the Department, another for the Annual Report of the Office of Experiment Stations, and a third for use at the St. Louis Exposition. These publications are in brief as follows:

Dietary Studies in Boston and Springfield, Mass., Philadelphia, Pa., and Chicago, Ill., by Lydia Southard, Ellen H. Richards, Susannah Usher, Bertha M. Terrill, and Amelia Shapleigh, edited by R. D. Milner. (Bulletin No. 129, pp. 103.)

Five dietary studies at the Boston School of Housekeeping, one at the Bible Normal College, then located at Springfield, now at Hartford, Conn., and 27 studies of poor families in Philadelphia and 33 in Chicago are reported.

Further Investigations among Fruitarians at the California Agricultural Experiment Station, by M. E. Jaffa, M. S., Assistant Professor of Agriculture, University of California. (Bulletin No. 132, pp. 81.)

The special object of these investigations, as of those reported in an earlier bulletin, was to study the value of fruits and nuts when these articles constituted an integral part of the diet. Nine dietary studies and 31 digestion experiments were carried out.

Experiments on the Metabolism of Matter and Energy in the Human Body, 1900–1902, by W. O. Atwater, Ph. D., and F. G. Benedict, Ph. D., with the cooperation of A. P. Bryant, M. S., R. D. Milner, Ph. B., and Paul Murrill, Ph. D. (Bulletin 136, pp. 357.)

Twenty-one experiments on the metabolism of matter and energy in the human organism, made with the respiration calorimeter at Middletown, are reported in this bulletin. The report also includes a description of the improvements and modifications of both the apparatus and the methods employed in the experiments. A summary of the experimental work with the respiration calorimeter to date is given, making 55 experiments in all, covering 150 days with subjects in the respiration chamber. The results of the experiments as thus summarized furnish a mass of data regarding the transformations of matter and energy which take place in the bodies of different persons under different conditions of muscular activity and with different kinds and amounts of food.

Experiments on Losses in Cooking Meat, 1900–1903, by H. S. Grindley, D. Sc., Associate Professor of Chemistry, College of Science, University of Illinois, and Timothy Mojonnier, M. S. (Bulletin No. 141, pp. 95.)

The results of 87 cooking experiments with meat are given in this bulletin. The purpose of this investigation was to secure data regarding the losses and changes resulting from cooking meat by various methods ordinarily used and also to find out the effects of cooking upon the nutritive value. The results are of much interest and practi-

cal value, but can not be considered final without futher experimentation.

Studies of the Digestibility and Nutritive Value of Bread at the Maine Agricultural Experiment Station, 1889–1903, by C. D. Woods, Director, and L. H. Merrill, Chemist, Maine Agricultural Experiment Station. (Bulletin No. 103, pp. 77.)

The results of 32 experiments with men on the digestibility of bread made from different grades of flour are reported in this bulletin, also of 30 artificial digestion experiments with similar kinds of bread. The purpose of the experiments was to find out the comparative nutritive value of different grades of flour. The results are in harmony with those obtained in earlier investigations and show that the breads made from all the common grades of flour are quite thoroughly digested, and, considering both composition and digestibility, differ little in nutritive value.

Poultry as Food, by Helen W. Atwater. (Farmers' Bulletin No. 182, pp. 30.)

Data regarding the composition and food value of poultry are summarized and discussed in this bulletin, the topics treated of including, among others, varieties of poultry, fattening poultry and its effect on food value, dressing and marketing, marks of good poultry, cooking, nutritive value of poultry and its cost, and the place of poultry in the diet.

Wheat Flour and Bread, by Harry Snyder, Professor of Chemistry, College of Agriculture, University of Minnesota, and Chas. D. Woods, Director Maine Agricultural Experiment Station. (Yearbook of Department of Agriculture for 1903, pp. 20.)

The results obtained in the investigations which have been carried on for a number of years on the nutritive value of bread made from different grades of flour are summarized and discussed.

Nutrition Investigations at the Government Hospital for the Insane, Washington, D. C., by W. O. Atwater, Ph. D. (Annual Report of the Office of Experiment Stations for the year ended June 30, 1903, pp. 34.)

The results of dietary studies carried on at the Government Hospital for the Insane are briefly summarized and discussed.

The following were prepared and submitted for publication, but were not actually printed until after the close of the fiscal year:

Canned Fruit, Preserves, and Jellies: Household Methods of Preparation, by Maria Parloa. (Farmers' Bulletin No. 203, pp. 37.)

Investigations on the Nutrition of Man in the United States, by C. F. Langworthy, Ph. D., and R. D. Milner, Ph. B. (Document No. 713, pp. 29.)

The last-mentioned article was intended primarily for distribution at the Louisiana Purchase Exposition.

In addition to the publications noted, abstracts of current literature relating to food and nutrition were published monthly in the Experiment Station Record, and a number of popular summaries of experiments on this subject at the agricultural stations were published in Experiment Station Work.

Irrigation and Drainage Investigations.

During the past year the work of the Irrigation and Drainage Investigations, under the direction of Dr. Elwood Mead, followed the same lines as heretofore. Increased attention has been given to the

irrigation problems of Kansas, Texas, and New Mexico. Cooperation with State experiment stations, which has always been an essential feature of this work, has been systematized and made more effective. In November last a meeting of representatives of this Office and of a majority of the western experiment stations was held in Washington, and arrangements were made for the carrying out of general cooperative studies in irrigation and drainage by the stations. As a result, nearly all of the State stations interested in irrigation are working together, under the general supervision of this Office, in collecting the results of practical experience in these two fields of agricultural development. Through this action all duplication of work and friction between this Office and the State stations is averted and the efficiency of both agencies has been greatly augmented. In its irrigation or drainage work the Office is now cooperating with more than half of the State experiment stations of the country and with nearly all of the western State engineers' offices. In addition, its irrigation work is being aided by special appropriations made by the States of California and Nevada. The investigations of the past year may be grouped under the following heads:

1. (*a*) Studies of the duty of water, including improvements to lessen seepage losses from ditches and promote the more economical and skillful application of water to crops. (*b*) Effects of impure water.

2. Gathering and publishing information and giving advice to promote the best development of irrigated agriculture in new districts.

3. Collection of information regarding the results of pumping water for irrigation and making field and laboratory tests of pumps to determine their efficiency.

4. Irrigation in the humid portions of the United States.

5. Studies of irrigation institutions, including the laws and customs under which rights to water are acquired and enforced, and the corporate and cooperative institutions which affect the economic relations of water users.

6. Drainage: (*a*) Investigation of conditions and preparation of plans for removal of surplus and seepage waters in irrigation. (*b*) The reclamation of swamp and overflowed lands in the eastern part of the country.

DUTY OF WATER.

The greatest single outlay of farmers under irrigation is the annual charge for water, whether paid as rental to ditch companies or for the maintenance and operation of ditches and pumps owned by themselves. The aggregate of these annual charges does not fall short of $20,000,000, and it is constantly increasing, for the irrigator must have water, whether the cost is large or small. During the past five years the price of water has risen enormously in nearly every Western State. Certain rights in Colorado which originally were purchased for $5 per acre now sell for $35 per acre. Where formerly 50 cents an acre-foot for water would have been regarded as a prohibitive price farmers last year paid $7 an acre-foot. This increase is due in part to the growing demand for water due to the extension of the irrigated area and in part to the fact that the increase in skill on the part of the older irrigators and the growing of higher-priced crops enables farmers to pay these increased rates with the same ease that they

formerly paid the smaller charge. Nevertheless, this change makes it harder for the beginner in irrigation to establish himself. He can not afford to learn by experience under these increased charges, as could the pioneers, and to succeed he needs the knowledge which the Government is collecting and publishing as a result of these investigations.

The extension of the reclaimed area in the West, both under public and private works, is being greatly aided, therefore, by relieving the individual from the necessity of going through a period of costly apprenticeship, which in the end is as likely to result in the adoption of bad methods as good ones.

Nor does the value of these researches and experiments end with their benefit to the individual irrigator. The public has an equally vital interest in the influence they are exerting. On many streams the area of land now under cultivation is already too great for the water supply. Where this situation prevails, if one farmer uses water unskillfully or wastefully it means inevitably that the crops of some other farmer must suffer because of it or that land must remain uncultivated. In addition, lavish use of water by one farmer not only injures his own land and crops, but oftentimes, through seepage, ruins the land of a neighboring farmer. The area farmed, the yield of crops, and the continued productiveness of the soil all depend on knowing how to use water aright and on the establishment of laws and regulations to compel this when men know and refuse to heed. The right use or disposal of water in agriculture is the central idea of these investigations.

In the beginning of these studies the work was confined to the collection of information showing the results of prevailing practice. During the past two years methods and apparatus which are the result of many years' study have been installed for carrying out original investigations to determine with greater accuracy than is now known the factors which influence the quantity of water needed and to determine just what amount of water and what method of application under given conditions will give the best results. The most extended of these studies are being carried on in the San Joaquin and Sacramento valleys, California, where the purpose is to determine the effect of varying the amounts of water applied to similar crops under otherwise similar conditions. Cereal and forage crops are being grown in basins in which the quantity of water applied in irrigation varies from nothing to 24 inches in depth. The purpose of this is to determine what amount will give the maximum yield. In addition, the same volume of water is being applied to crops in different ways in order to determine which of the four general systems of irrigation in use—furrows, flooding, checks, or compartments—gives the best results. It is too early to forecast what will be the result of these experiments, but enough has already been disclosed to show that they are to profoundly influence the decision of courts with respect to water titles and to greatly increase the area which a given volume of water will irrigate. In the tests to determine the best method of applying water the volume used to irrigate 65 acres of land when spread over the surface in flooding irrigated 100 acres when applied in deep furrows, almost doubling the value of water as measured by its service. In addition, the method which required the smallest quantity of water showed also the tendency to cause plants to send their roots deeper

in the soil in search of plant food, thus adding to the area from which food is supplied and lengthening the time required to impoverish the soil.

The cooperative studies of the duty of water in Utah are intended to determine the effect of varying quantities of water on crop production, the depth applied to the different plats, ranging from 2.5 to 60 inches. Other studies were to determine the effect of varying the time of applying water. Some plats were irrigated once, some irrigated three times. These experiments are being carried on with especial reference to the influence of the time of irrigation on the growing of cereal crops, and especially the influence on the yield and chemical composition of grain of the application of water about the time it matures. As in California, the relative quantity of water required by flooding, furrow, and subirrigation is being studied. With this, methods for conserving the soil moisture and preventing evaporation after irrigation are being tested, some of the plats being cultivated the first day after irrigation, others the second, others the fourth, and others one week later. Others are not cultivated after irrigation at all. The relative effects of scanty and copious irrigation on the chemical composition of crops, as well as on the yield, are being studied. In connection with these advanced researches, measurements are being made to determine the duty of water as affected by different kinds of soil and the effects of irrigation upon the fertility of the soil, both through the addition of fertilizing material in the water used and the action of different quantities of water on the movement of nitrates in the soil.

EFFECTS OF IMPURE WATER.

In many sections of the West the impurities carried by irrigation water have a marked influence on the success of irrigation. The sediment carried by streams is generally regarded as being valuable because of its fertilizing properties, although little is known regarding its exact value. That the sediment-laden water of streams has a value in preventing seepage losses has long been recognized, but in some cases, especially in the Arkansas Valley, irrigators complain that this sediment acts injuriously in the irrigation of fields by preventing the rapid absorption of the water. The amount of alkali contained in water is always an important question, and in many of the pumping plants the percentage of alkali in the water is so large as to threaten to work a permanent injury to the soil.

The character of the water used in irrigation is also a live question with the rice irrigators along the Gulf coast. Two years ago the pumping plants made such demands on the streams as to cause the salt water to flow up from the Gulf and take the place of fresh water coming down from above. The water became so salty in a few cases as to destroy the crops, and the percentage of salt added to the soil, if continued throughout successive years, would undoubtedly tend to injure it if not washed out the succeeding year by the application of fresh water during the flood period. This, however, is likely to take place, and the important question with irrigators is to know just what percentage of salt in the water used in irrigation will endanger the growing crop. In order to answer the inquiries made of this Office, a cooperative arrangement was made with the Bureau of Chemistry of this Department by which the field agents of this

investigation collect samples of water and forward them to that Bureau for analysis. These analyses will enable the Office to give advice to inquirers regarding the influence of impurities, whether beneficial or otherwise.

PROMOTION OF CORRECT METHODS IN NEW DISTRICTS.

Supplementing these researches into the scientific problems of irrigation, we have been collecting information regarding methods and cost of preparing land for irrigation. The results show the need of a better understanding of this subject by farmers. Much has been done to aid engineers in the right planning of dams and canals, but farmers have not been aided in making equal progress in preparing their fields to use water. Their knowledge of methods is to a great extent confined to what they see in their own neighborhoods, and it has been as much a matter of accident as of intelligent choice whether these methods were best suited to their conditions. Because of the fact that the irrigated valleys of the West are, as a rule, small and isolated and often settled by people from one locality, it is very likely to happen that each community will follow the same method. This will be the one brought from their former home if they are a community of irrigators, or the one used by the pioneer in this development. The separation of irrigated valleys—the isolation of the farmers of different districts—is a serious obstacle to improvement in irrigation methods and the adoption of methods best suited to their conditions. If farmers could travel they could find in the wide range of climate, soil, and crops nearly every condition with which irrigators have to deal. They could also witness almost every method of applying water to be found in the world. More than 30 different methods of applying water in irrigation have been noted by our experts. This does not mean 30 different systems, but different modifications of what we have classed in four systems. The individual irrigator is, however, absorbed in cultivating his land and making a living for himself and family. He has neither the time nor the means to observe and compare the methods and practices of different sections. What he needs is to have this done for him by trained and experienced observers. Recognizing this, this Office has undertaken in a systematic way to describe the different methods of preparing land and applying water and to advise farmers with respect to their adaptability to different localities and crops.

These studies have also shown that the cost of preparing land is far greater than has been realized, varying under flooding from $2 to $5 an acre, and under the check system from $8 to $25 an acre. The importance to the beginner in irrigation of being able to select the right method of applying water and the cheapest method of preparing his land can therefore scarcely be overestimated. Every year tens of thousands of farmers who know nothing whatever of irrigation emigrate to the West. They have practically to begin anew in learning how to irrigate and how to deal with strange economic and climatic conditions. It is the purpose of this Office to aid them to become skillful and efficient with the least loss of money and time. This is being done in part by the collection of the results of practical experience of farmers and publishing the same in bulletins, and in part by the employment of expert irrigation engineers

to make studies of the conditions in new districts and give personal advice and direction to beginners. In this way all that has been learned by experience in the past is made available to new communities, and the saving in the expense of preparing land and in securing an increased duty of water through the influence exerted has been remarkable.

The Modesto and Turlock districts in California will serve as an illustration of this feature of the work of the Office. The canals of these two districts will water 260,000 acres of land. The farmers on this land have heretofore cultivated it without irrigation, and although living in a State where irrigation is widely practiced, know little personally of the methods of applying water. Immigrants who purchase land there are as a rule from the East and are equally uninformed regarding how to prepare their land to apply water or how to use the water afterwards. The districts asked for our cooperation in studying the best methods of using water and in securing the adoption of these methods at the outset, and an expert was detailed for this work. The quantity of water used is being measured. Test wells have been dug to show the rate of the rise of soil water in order to show where overirrigation is being practiced and to give warning to irrigators in the lower part of these districts should the increase in seepage threaten to make drainage a necessity. In addition to the presence of this expert, the district has been visited by the chief of these investigations and carefully studied by the expert in charge of the Pacific district. Leaving out of account the value of the information gained to be subsequently published in bulletins, the result of the first year's work has been to demonstrate the value of the irrigation of small grain and the fact that it could be irrigated by simpler and far less expensive methods than those generally practiced in the district. The method of preparing land usually followed by the beginners was costly and not adapted to the scope and the kind of agriculture to be followed in a portion of these districts. Competent observers estimate that the value of these studies in the saving of water, money, and time will amount to more than ten times the appropriation for the entire work.

Similar aid is being extended to the beginners in irrigation in southern and western Texas, where agricultural settlement during the past two or three years has been going on quite rapidly, one expert being assigned to the territory north of the Texas Pacific Railway and another to the region along and south of the Southern Pacific. In both of these districts the greatest development is to come from the use of small quantities of water made available either by pumping or by the building of reservoirs. Reports from farmers who made use of the services of these experts show that in single instances the remedying of mistakes or the prevention of others has more than saved the salaries of our agents. The number of individuals who can be reached personally is comparatively small, but the published results will be available for distribution, making the lessons of experience and the advice of our experts available for all who wish to make use of them. In addition, valuable data have been gathered regarding the extent of future development and the best means of bringing it about. These show that there are great possibilities in this section which will be realized as soon as farmers know how to

proceed without the unnecessary expenditure of time and money in unsuccessful experiments.

What is true of Texas is true also of many sections of the broad belt of semiarid country east of the Rocky Mountains, extending from the Gulf of Mexico to Canada, and numerous scattered areas in each of the arid States and Territories. In these districts farming by rainfall is successful in a majority of seasons, but there are years of drought which are disastrous if dependence is placed on rainfall alone. If, however, a small area can be irrigated and given intensive cultivation it can be made to grow forage, fruits, and vegetables enough to carry a farmer's family and work animals through the dry years, and in this way permanent and profitable settlement can be assured. While the acreage irrigated by each individual under this system would be small, probably varying from 5 to 20 acres, the aggregate for the entire country is certain to be large, and it will add to the value and productiveness of the surrounding country by making it more attractive in appearance and by making it possible to use the grazing land to better advantage.

It was impossible with the force available to respond to all the requests for investigations. This work should be extended next year, and an increase in the appropriation has been asked for to permit of this.

PUMPING INVESTIGATIONS.

The pumping investigations have included the collection of information regarding the actual results of pumping where carried on by farmers, and field and laboratory tests to determine the best methods of installing and operating pumping plants. During the past summer continuous records have been kept of the operation of a large number of pumping plants to show the amount of fuel used, the amount of water lifted, the area of land irrigated, and the value of the crops grown. These records have included pumps of different types lifting water from a large range of depths, and many forms of power—gasoline, crude petroleum, steam, and electricity, the latter being in some instances generated by steam power and in some instances transmitted from water-power stations in the mountains.

One of the sources of uncertainty in the installation of a pumping plant is the lack of knowledge as to how the operation of the pumps is to affect the level of the water plane from which the supply is drawn. In some instances where pumping plants of large capacity have been installed the water plane is rapidly lowered until it is so far below the pump that water can not be lifted by suction, or so far as to greatly impair the efficiency of the pump. Perhaps one-half of the failures reported have been due to the lowering of the water plane. A number of Western manufacturers of pumps and contractors who install pumping plants are now refusing to fill orders until a preliminary test to determine the rate at which water can be drawn from the soil has been made. This would seem to be a wise precaution in all instances. The depth to which the water plane is lowered has much to do with determining the relative efficiency of vertical and horizontal centrifugal pumps, and is one of the subjects about which additional information is needed. It is believed that the information on this subject gathered by the agents of this investi-

gation during the year will be of great service to pump makers in showing them what conditions must be met, and to farmers in showing them what kinds and sizes of pumps are best suited to their needs.

In Texas and New Mexico the operation of a large number of pumping plants has been studied. Where pumps have been properly installed and where the lift is not more than 50 or 60 feet pumping has proven highly profitable. On the farm of Mr. J. A. Smith, north of El Paso, about 200 acres of alfalfa are being irrigated from pumps lifting water more than 30 feet. The estimated expense of growing this, including the cost of pumping, is $5 a ton. The hay is worth $15 a ton, and about 5 tons to the acre will be grown this year, making the net profit, not including interest on the cost of land and pumping plant, $50 an acre. Near San Antonio pumping plants are lifting water in some instances from a depth of 46 feet, yet the parties operating these plants are paying all expenses of pumping and in addition a rental of $10 per acre for the land. Prior to the beginning of irrigation by pumping this land could be used only for pasturage purposes, and the income from this was hardly enough to pay the taxes on the land.

Conditions in the Southwest show that the greatest need in the extension of irrigation by pumping is the training of farmers to have a better understanding of the mechanical principles and of the practical operation of machinery, both of engines and pumps. Until they do have this understanding they are always in danger of being victimized by ignorant or unscrupulous dealers. In some parts of the Southwest there are to be found pumping plants which are being operated with success and profit, while in the same neighborhood there are other pumping plants which have been abandoned. This difference in results seems to be due to the tendency of farmers to buy the cheapest machinery offered and the willingness of some dealers to furnish inferior or unsuitable machinery at attractive prices. Numerous suits over failures of pumping plants to meet stipulated requirements have been instituted in both Texas and New Mexico. These could have been averted if the farmers had had a better understanding of the kind of machinery they ought to have ordered and the relation between its capacity and the work to be done.

To end these mistakes and controversies many measurements by this Office were made to determine the amount of water used to irrigate an acre of land and of the seepage losses from clear water pumped from wells. This was to show how much greater this was than the loss from the sediment-laden waters of streams. The extent to which the water plane was lowered by pumps, the relative cost of different kinds of fuel, and the ease or difficulty with which farmers can operate engines using these different kinds of fuel were all observed. Experience is showing that it is sometimes mistaken economy for the farmer to adopt the cheapest fuel as well as to purchase the cheapest machinery. Theoretically crude oil is the cheapest fuel to be had in either California or Texas; but while experienced engineers may be able to operate a crude-oil engine continuously, in practice, gumming, or the accumulation of carbon on the packing rings of the piston, involves the average farmer in mechanical difficulties which he can not overcome and may cause the stoppage of his plant at the very time when the loss of water for a day or two means the loss of his year's work.

There is need of experiments to show the practical possibilities of windmill irrigation. The most noted windmill-irrigation district at present is at Garden City, Kans. The working of these mills has been studied during the past year. In many instances the cheapest and best form of power is wind, and it is believed that by the use of larger mills of recent design much can be done.

At Lonoke, Ark., Mesilla Park, N. Mex., and Berkeley, Cal., we are cooperating in making careful tests of different types of pumping machinery to determine their efficiency. Laboratory tests are being made at the University of California. The pumping investigations at Mesilla Park, N. Mex., will aid the farmers of the Rio Grande Valley to determine what kind of machinery they ought to buy and how to operate it successfully. There is apparently an immense body of soil water underlying this valley from above Albuquerque to El Paso. This can be drawn on continuously for irrigation, because it will be replenished by the floods which at irregular periods pass down the stream. The conditions are here unusually favorable for the operation of small pumping plants, because they need not be run continuously, but only when the surface supply in the river fails. Through the combined use of surface and subterranean water supplies a large area of land can be reclaimed in this valley, but before farmers will undertake this they desire to know more than they now know about the cost and operation of pumping plants. The work at the New Mexico Experiment Station is intended to answer these inquiries. In connection therewith measurements are being made to ascertain the duty of water and to determine how seepage losses from pumped water vary from seepage losses in ditches filled from the surface flow of the river. It appears to be demonstrated that pumping can be profitably employed in the Rio Grande Valley to supplement the surface supply of the river, and that it is entirely feasible to grow crops with pumped water alone. Thirty-one thousand two hundred and fifty pounds of onions per acre were grown this season. The water for irrigation was furnished by pumping, at a cost of $15 per acre. The onions sold for $703 an acre and the net profit was $500 an acre. The results of the tests on fuel showed that the most expensive was gasoline, followed in the order named by kerosene, coal, wood, and crude oil.

A pumping plant has been installed at Lonoke, Ark., in cooperation with the State experiment station to determine the quantity of water needed to irrigate rice and the cost of supplying it by pumping. In the vicinity of Lonoke is a large tract of land not well adapted to the growing of other crops, but believed to be valuable for rice growing. The pump installed is large enough to irrigate 50 acres, but only 10 acres are being irrigated this season.

Studies of the duty of water in the rice districts of Louisiana and Texas have been continued. Records are being kept of the operation of some of the large pumping plants in order to determine the cost of lifting water and the relative economy of different kinds of fuel.

IRRIGATION IN THE HUMID PORTIONS OF THE UNITED STATES.

In 1903 the legislature of Wisconsin appropriated $2,500 a year for two years to be spent under the management of the director of the Wisconsin experiment station in the development of the cranberry

industry of that State. This Office has been cooperating with the State station in making a study of the conditions needed to make this development profitable. A lease has been secured from the Wisconsin Cranberry Association of about 9 acres of cranberry land 10 miles southwest of Grand Rapids. This land has been planted by the association with different varieties of vines, representing all those grown in the United States and Alaska, as well as those received from foreign countries, including Norway, Russia, Siberia, and Canada. It also includes 2 acres of standard vines, on which experimental studies in the application of water will be made. A small reservoir about an acre in area has been constructed to furnish water for immediate use and provide for studies of evaporation and seepage under conditions which can be controlled.

The cranberry industry is largely dependent upon the use and control of water. Under common practice at present vines are covered with water throughout the season, and more or less completely covered at any time during the growing season when there is danger of frost. They are also covered at times for a few hours to kill worms. On the other hand, the water must be drawn off early enough in the spring to let the marsh warm and secure an early start for vegetation. It must be drawn off quickly in the morning after the danger of frost has disappeared, or the sun shining on the berries through the water will scald them. For the same reason the water of heavy rains must also be quickly drawn off. All this calls for large amounts of water and for drainage capacity which will remove it rapidly. The losses and failures in cranberry growing have been largely due to the failure to provide adequate control of the water supply.

The work being carried on during the past season has included: (1) The collection of data from cranberry growers as to the amount of water used and the practice in using it; (2) to determine losses by evaporation and seepage from ground covered by vines as well as from reservoirs; (3) to determine the effect of standing water of different temperatures on the berries and vines at different stages of development; (4) to determine the coefficient of resistance of peat ditches used in carrying water to and from the vines; (5) to determine the proper method of using water to prevent frost; (6) as to the effect of drainage of adjacent areas on the amount of water required to irrigate cranberry beds.

A similar investigation, in cooperation with the State experiment station, has been inaugurated in New Jersey, the work this year being confined to the collection of facts showing the methods employed by the New Jersey cranberry growers in watering and draining their fields. It is intended to follow this up by obtaining control of cranberry beds suited to the purpose and carrying out studies similar to those now being made in Wisconsin.

The cooperative experiments in the irrigation of corn, orchards, and garden vegetables, especially asparagus, at the Missouri Experiment Station, have been continued, the purpose being to determine how far it is possible to prevent by copious irrigation the inroads of rust in the growing of asparagus, and to show whether the irrigation of ordinary field crops in the Mississippi Valley is likely to be profitable.

LAWS AND INSTITUTIONS.

The studies of the laws and institutions relating to irrigation, required by Congress to be carried on by this Office, have been continued during this year. One bulletin, dealing directly with this subject, has been published, another, dealing largely with it, has been issued, the field work for three others has been completed, and the reports will soon be published. This work has dealt almost exclusively with the acquirement and enforcement of water rights. The Arkansas River in Colorado, where conditions affecting the acquirement of water rights were studied,[a] illustrates the importance of these investigations. There are 1,900 ditches taking water from this river in Colorado. The aggregate length of the main canals is more than 3,000 miles, and their construction has cost about $9,000,000. From them 600,000 acres can be watered, and more than 400,000 acres are now being irrigated. Between 7,000 and 8,000 people depend on these ditches for their water supply, and they have invested large sums of money in the purchase of rights from the canal companies. The value of the irrigable land under these canals is from $25,000,000 to $30,000,000. The value of this land depends not on its location or natural properties, but on the possibility of securing a water supply. The methods of acquiring water rights and a knowledge of the conditions affecting their stability and value are therefore of first importance. The water right gives value to the land, and if the right is worthless the money spent for both land and water is lost. The conditions which determine the value of a water right acquired under either the laws of the State or from a canal company are peculiar to the arid region and are not generally understood by settlers from the East. The work of this Office in determining the actual amount of water used in irrigation is destined to result in the saving of millions of dollars to the public and to irrigators in preventing the lavish disposal of water supplies. Until recently water has been decreed away by the courts with a generous hand. Few measurements were made of the volume of water used in irrigation prior to those undertaken by this Office. When controversies arose or when titles to water were being established they were settled by what interested witnesses fancied they needed. In one instance one irrigator believed that it required 1 miner's inch for each irrigated acre; another that 2 were needed, and a third testified that he required 3 inches per acre for thorough and complete irrigation. The results of our measurements of the water used on 125,000 acres in the same State show that irrigators do not use more than 0.5 inch per acre on the average, and that under the most wasteful methods. The influence of these measurements in preventing the giving away of the water supply and in putting the administration of streams on a just and orderly basis can not be stated in dollars and cents, because the benefit is not limited to this year or next, but must affect development to the remote future.

Nor does this end the significance and importance of this information. The 8,000 irrigators of the Arkansas Valley are scattered over a territory more than 200 miles long and 50 miles wide; and even if each has a good right to water it is in the power of any one of them to interfere with the rights of all those below him on the stream by

[a] Bul. 140, Office of Experiment Stations, U. S. Dept. of Agr.

taking more water than he is entitled to. Unless the head gates of the 1,900 canals are adjusted so that no canal can take more than its proper share, and unless those not entitled to water are closed entirely when the protection of inferior rights requires it, there must inevitably be injustice, bitterness of feeling, and failure of crops. Such a regulation of gates can be made only by public officials, since contending parties can not be left to regulate each other's gates. Six States have provided for the distribution of water by public officials. Their systems differ in detail and in the powers assumed by the officials under their respective State laws. A study of the workings of these systems in the six States has been made to determine their efficiency in protecting the rights of water users, in order that these States may intelligently modify their systems, if found desirable, and the other States, as development forces them to provide administrative systems, may profit by the experience of the former.

The first bulletin of the report on irrigation in Italy shows how far wise legal and social institutions have contributed to the agricultural prosperity of that country. In Italy, as in the arid West, streams are considered public property, but public control is much stricter than in this country. Here rights are acquired under general rules and without public supervision. There a Government commission examines and passes on each project and determines whether it is for the public good, in this way providing for the best use of the water supply. In both the division of streams and canal management cooperation plays a much larger part than in this country, but not more than it is destined to do here in the future. In one section of the Po Valley an association of water users has 14,000 members, operates 9,600 miles of ditches, has 266 miles of telegraph and telephone lines, supplies water to 141,000 acres of land, and does a business of $600,000 a year. Such cooperative control could be introduced to advantage in many of our communities.

During the summers of 1903 and 1904 agents of this Office have made a study of the economic conditions governing the use of water in the rice districts of Louisiana and Texas. The raising of rice by irrigation in these States has reached immense proportions without any appreciable public control of the water supply. Especial attention has been given to the effect of this lack of law upon the industry and to the customs which have grown up there in the absence of legislation. A typical stream has been chosen and a minute study of conditions on that stream made. The report of this work, which it is hoped to publish shortly, will doubtless encourage the enactment of laws which will best promote this industry, which has done so much to give value to the agricultural lands of the Gulf Coast.

The study of the questions growing out of the use of interstate streams for irrigation, begun in 1902 and continued in 1903, has been completed during the present season. The Platte River and its tributaries were chosen for this study because it is a typical interstate stream, flowing through three States, each having laws and institutions somewhat different. In 1903 a study was made of the laws of the three States and the rights which had been acquired under them, of the interpretation of these laws by the courts of the three States, and of the systems of canal management and operation which had grown up under the laws and decisions. Data were gathered showing

the use to which water was put in different sections and measurements and records of the flow of the streams made to determine the effect of diversions from the upper sections upon the supply for irrigation along the lower sections. A proper determination of this last question requires a knowledge of the flow of the streams before irrigation began, but no records of their flow at that time are in existence. It has, therefore, been necessary to secure statements from those familiar with the stream at that time as the best available evidence on the subject. A large number of such statements were secured in 1903, and many more during the present season. With these statements, the studies made in 1902 and 1903, and observations made during the season of 1904, a report is being prepared which will show the conditions as they have grown up in the three States under the theory that each State has absolute control of the stream within its borders regardless of rights in the other States; the effects of diversions in the upper States upon rights in the lower States; the probable effects upon agriculture in the different States of the recognition of the interdependence of rights regardless of State lines, and the status of existing rights under different doctrines as to interstate rights. The relation of rights to the same stream in different States is not well settled at present, as there is no legislation on the subject and only a few of the many questions which must arise have been passed upon by the courts. The proper settlement of these undecided questions requires a knowledge of physical and economic conditions and of existing rights, and it is the purpose of this report to supply that knowledge in regard to a typical interstate stream, the Platte River.

There are few streams in the country whose waters are of greater value for agricultural purposes than the Yakima River in Washington. The soil along this river is remarkably fertile, and the climate permits of the growth of a wide range of products. Notwithstanding the absence of any legislation for the proper establishment of water titles or the protection of irrigators in times of scarcity, large and costly canals have been built and an immense area of land has been brought under irrigation. This development has not only added to the wealth of the State through the creation of land values, but the farming lands are the principal reason for the existence of a number of flourishing towns. All this wealth has its foundation in the use of the water of the river, but the time has come when this use must be regulated either by laws or by effective cooperative arrangements on the part of irrigators. If disastrous controversies and serious loss and injustice are to be averted, the first step toward this is a proper knowledge of existing conditions. To have either wise laws or working agreements, the quantity of water needed to irrigate an acre of land must be known, the actual quantity being diverted by each ditch measured, and the extent of seepage losses determined. At the request of a large number of irrigators and canal owners, this Office for the past three years has been carrying on extended measurements to furnish these facts, the work being conducted under a cooperative arrangement with the State experiment station of Washington.

Similar cooperative studies are being made in Idaho in connection with the State engineer's office, the field of this year's work being the valley of Raft River.

DRAINAGE INVESTIGATIONS.

That irrigation and drainage go together is recognized in every irrigated country, both by the practical irrigator and in legislation. That this country is to be no exception to the rule is now becoming manifest in the conditions which exist in every one of the older irrigated sections of the West. Either through the leakage of canals or through lavish use of water by irrigators, many thousand acres have become bogs and marshes through the accumulation of surplus and seepage waters. The rise of the soil water has tended to drown out the roots of trees and plants; in addition, the seepage water passing down from canals and overflowed fields carries with it the soluble salts of the soil, and as it evaporates these salts are left, becoming more and more concentrated until they prevent the growth of crops. Seepage water is, therefore, a double menace. It drowns out vegetation by excess of water in some instances and kills it by excess of alkali in others.

The drainage problems of irrigated districts are not the same as those of the eastern part of the United States. Many new and complex questions have to be considered. The quantity of water to be removed can not be estimated with the same accuracy that it can where drainage is simply a question of getting rid of the rainfall, the amount of which is known within close limits. The source of the water supply is oftentimes obscure, and there is as yet a lack of practical experience in regard to the operation of drains and the durability of tiles where subject to the action of alkaline water. It is impossible without a preliminary study of conditions to give reliable advice to farmers as to how they can restore their damaged fields. The preparation of drainage plans for any particular district requires a knowledge of the rapidity with which the soil water rises when irrigation begins in order to fix the capacity of drains to maintain it at a desired level. The sources of the accumulated water must be determined in order to know whether relief can be had by intercepting ditches or a regular system of open or under drains.

The most extended studies of these questions carried on during last year were made in Utah in cooperation with the State experiment station. These included an examination of the conditions in Emery, Washington, and Cache counties. In the former two counties the need of drainage is seriously felt, and prompt and energetic efforts on the part of landowners will be required to restore their fields to their former productiveness. A cooperative experiment has been inaugurated in Cache County to determine the best method of reclaiming the swamp lands of Cache Valley. A tract of 20 acres has been secured, in which drains have been placed in such a way that their action may be observed and the quantity of water carried off measured. It is expected to gather data from this experiment which will aid in determining the size of drains needed for the reclamation of other areas in this valley. The importance of this reclamation work is great. Many thousand acres of what was formerly the best land in the valley have become so water-logged that they now produce only inferior grasses. In connection with these drainage tests, the land is to be cultivated by the owners under the advice of the station and this Office in order to determine the advantages resulting to various crops and the profits which will accrue to the farmer from

such improvements. In connection with this a series of ground-water wells has been placed across the valley, from which will be learned the effect of irrigation upon the water table of the soil under various conditions of slope and surface treatment.

Measurements of the fluctuation of soil water are being made in Yellowstone Valley, Montana, where 60,000 acres of land have become water-logged and need drainage in order to be restored to their former productiveness.

The legal problems connected with the carrying out of drainage projects in the arid region are more complicated than those in humid lands. The drainage of large irrigated districts to be effective has to be carried out in a comprehensive way. Where the seepage water is removed by building intercepting drains the actual works which afford relief may be far distant from the lands benefited. In other cases the farms that are responsible for the injury may not suffer from it, while farmers who are skillful and economical irrigators may have their lands ruined by the wrong methods of neighbors living higher up on the slopes. This makes the fixing of the boundaries of drainage districts in areas under irrigation and the assessment of damages and benefits resulting from such improvements far more troublesome than where drainage is simply to remove rainfall. Both the preparation of the engineering plans and the management of the legal and financial features of drainage require broader experience and better understanding of what may be required in the future than is, as a rule, possessed by local authorities. For this reason the services of the experts of this Department have been sought by individuals and by districts and communities seeking to frame laws or inaugurate extensive works for the comprehensive improvement of lands.

In the East farm drainage has long been recognized as one of the important aids to increased production and enough experience has been gained to enable farmers to carry out small projects without any special aid or advice. Where, however, the drainage of large areas is involved, there is need of expert advice in solving both the legal and engineering problems. It is now recognized, also, that in many localities much drainage work has been poorly done and that more scientific and thorough methods are required in draining land for the more intensive cultivation now demanded on high-priced land. Laws for the organization of districts, the best methods of levying and collecting assessments, the proportioning of the sizes of tile, and the distance and direction of ditches are all questions for practical experts. Ability to avail themselves of the advice of a few highly trained drainage engineers has proved of great value to the farmers of the Middle West and has done much since this investigation was started to promote the carrying out of these improvements. This demand led Congress at its last session to change the title of the investigation from "Irrigation" to "Irrigation and Drainage."

During the past summer a study was made of the drainage problems of the Illinois River. Levee districts have been organized along this stream to reclaim altogether about 74,000 acres of land. To prevent the overflow of this land during floods, levees have been built to keep the river within its bounds and drains have been dug to carry off the surplus water behind them. When the river is low, this surplus water can be carried off by gravity; when the river is high, it must

be lifted over the levees by means of pumps. In some of these districts the expenses for ditches, levees, and pumps have amounted to as much as $14 per acre, and in some years the cost of pumping has been as high as $1 per acre. During the last two years nearly all of these reclamation works have for various reasons failed. The facts gathered show that in some of the districts the levees were not built high enough. During floods the water flows over them, and it either swamps the pumps or causes too great an outlay in its removal. In other cases large quantities of water seep under the levees, because of lack of care in preparing the foundations. The slopes of the levees have generally been made too steep on both sides. Our expert recommends the building of levees with slopes as flat as 3 to 1, and planting these slopes to grass, keeping them free from weeds and brush by pasturing or otherwise. In some cases failures were due to the purchase of unsuitable pumping machinery; in others, to drainage water from the hills, which was not fully prevented from entering the protected area. Many of the difficulties encountered could have been avoided and the loss of many thousands of acres of crops prevented by adequate and properly constructed works.

The past summer's work in drainage also included giving advice regarding the legal and engineering features of a number of important districts in Nebraska, Iowa, South Dakota, and Wisconsin. A study of the drainage problems of Indiana has been inaugurated in cooperation with the State agricultural college and experiment station.

An investigation of the practicability of draining portions of the Everglades in Florida has been made in cooperation with the Bureau of Plant Industry. At present this immense swamp is practically worthless, but it seems to have agricultural possibilities which would make its reclamation second in engineering and agricultural importance only to the bringing under cultivation of the flat lands in Italy along the Adriatic or the marsh lands in the north of Holland and Germany. The soil and climate of this region, as far as tested, seem to adapt it to the cultivation of citrus and other subtropical fruits, and if the experiments now being made prove this to be true, its reclamation will add immensely to the productive capacity of the country along certain lines.

Two important investigations asked for have had to be deferred. One was a study of the drainage problems of the swamped lands of Wisconsin, and the other, certain drainage studies in Louisiana and Mississippi. The interest in drainage and the fact that in many districts work is now being inaugurated make it exceedingly desirable that this work be extended, and provision for this increase has been made in the estimate.

RURAL ENGINEERING.

The experience of farmers in pumping water for irrigation shows that success depends in large measure on a better understanding by them of mechanical principles. Until they have this training there will be waste and loss in buying misfit machines and in misusing good ones. The need of this training is not confined to the selection and use of machinery to pump water for irrigation. The providing of power and selection of machinery to supply water for domestic and stock purposes is one of the live problems of the farm all over the country.

The money spent in buying and operating this one class of farm machinery runs into millions of dollars each year. Until recently windmills were the chief motor employed. Now dynamos and gas engines are beginning to be used. As a whole, the results are not satisfactory. There are too many breakdowns, and the machinery wears out too soon. In order to better these conditions, the agricultural experiment stations of Iowa and Wisconsin are cooperating with this Office in making a series of experiments to determine the efficiency of windmills, and the Office is gathering data for a bulletin on their construction and operation. The makers of pumping machinery are as anxious as the farmers to find out and remedy the weak features of present designs, and are offering to donate all the machinery required for these tests.

The need of a better understanding of the principles of mechanics and of better training in the use of machinery is one of the features of American agriculture which has not yet been adequately recognized in the courses of instruction in our agricultural colleges or in the work of this Department. We are the greatest makers and users of farm machinery in the world, and it is owing to this fact, more than to any other single cause, that we have been able to maintain our agricultural supremacy in the markets of the world. The cost of this machinery to the farmer is one of his heaviest outlays, and the gain by increasing its life through better care or its efficiency through more skillful operation can hardly be overestimated. The difficulty of doing this is greater to-day than ever before. The character of this machinery every year becomes more complicated, requiring increased knowledge of engineering principles on the part of farmers. The traction engine, the steam plow, the combined harvester and thrasher operated by steam power, the automobile, the growing use of electricity as a motive power on the farm, the machinery now required in dairies, in the cultivation and harvesting of rice, in the growing of sugar beets and manufacture of beet sugar, are illustrations of the momentous changes in the character of farm machines which have taken place in the last fifty years. The increase in skill and mechanical knowledge required by farmers to operate these complex and costly machines compared to what was needed to operate the primitive tools of half a century ago can not be stated in percentages. The leading European governments have recognized the revolutionary character of this feature of farm life more clearly than we have. Especially is this true of Germany and France, where both Governments are continuously investigating this subject. The recent investigations of the German Government to determine the possibility of using alcohol, which can be purchased at home, to supplant gasoline, which is not produced in Germany, to operate farm engines, is an illustration of the governmental studies being made in Europe.

Nor is this need of increased knowledge of rural engineering confined to machinery. The changes which are taking place in the character of farm buildings make a knowledge of the principles of structural design and of ventilation and the cost and availability of different material all matters of importance to the individual farmer and to the country as a whole. Many ill-lighted, foul-smelling, poorly ventilated barns which are prolific breeding places of tuberculosis and other diseases show the need of a better understanding of ventilation in the housing of live stock. Yet we do not know either

the effect of poor ventilation or the most efficient means of securing good ventilation. Scores of the costliest barns built during the past five years have been complete failures in this particular, although they were intended to accomplish this special result.

Farmers are also confronted by the necessity of a change in past practice in the material used in farm buildings. The use of wood must in the near future be largely abandoned. Timber is now becoming so scarce and costly that it is being supplemented by brick, stone, and cement. The improvements in the manufacture of cement and in the methods of employing it in buildings have caused this to be called the plastic age. They constitute one of the most significant developments of the last ten years. This Office can render the agriculture of the country a valuable service by showing farmers how to make the best use of these advances in industrial methods, by organizing this work in such a way as to keep track of progress made in foreign countries, and by supplementing and aiding the work being done at the different agricultural experiment stations. The more progressive of these institutions have already recognized the significance of the changed conditions before described. Illinois, Wisconsin, Iowa, and a number of other leading institutions have already established courses in rural engineering. The need of additional data has led them to call on this Department for information which can not be supplied, and to ask aid in the conduct of investigations needed to promote the efficiency of machines and lessen the expenses to farmers of their purchase and operation.

It is one of the functions of this Office to aid these institutions in bringing each line of work to its highest efficiency in teaching as well as in experimentation. In no direction has there been a greater demand during the past two years for such aid than in the conduct of investigations and preparation of courses of study in rural engineering. The colleges which have attempted to establish courses in farm mechanics or give instruction in the location and designing of farm buildings have had to confront the fact that the data for putting these subjects clearly and specifically before their students are very meager, and they are looking to this Department to aid them in the direction of investigations and the gathering and collation of information to meet this want.

Objection has been made to the extension of the Department's investigations in these lines to include studies of farm machinery on the ground that this is likely to involve the Department in contests with manufacturers of such machinery or to unduly favor the interests of individual manufacturers; but the studies and tests which the experiment stations have already made of dairy machinery, some of which have been on quite an extensive scale, have demonstrated that it is possible to enlist the sympathy and support of manufacturers in such work and to secure results which are of benefit to farmers and manufacturers alike. Such studies, when properly made, deal with types of machines and the principles of construction as related to the practical use of such machinery, and when results of value are obtained all manufacturers alike can avail themselves of them.

The extended studies now being conducted by the Irrigation and Drainage Investigations include a large part of the field of rural engineering, and with its studies of engines to operate pumps there can be carried on the collection of data concerning the operation of

motors for thrashers, plows, dairy machinery, etc. With its studies of drainage go naturally studies of sanitation. With its studies of the use of cement and concrete in flumes and pipes and reservoirs for irrigation go the studies of the use of cement and concrete in other farm structures. It is therefore recommended that provision be made for this by a special appropriation of $5,000. As stated in my previous report, this would include:

(1) Preliminary work in the collection and publication of information regarding the evolution, character, and uses of farm implements and machinery in this and other countries. This is important, because the available literature on the subject is scattered, fragmentary, and out of date. A small beginning has just been made in this direction in a bulletin on The Evolution of Reaping Machines, recently published by this Office, and another bulletin describing corn-harvesting machinery, which is being prepared.

(2) Laboratory and practical tests, involving a study of principles of construction and methods of operation of farm implements and machinery with special reference to efficiency and economy. These might very properly include certain strictly technical inquiries regarding the fundamental nature of the various mechanical farm operations with a view to suggesting the best means of performing them with the implements and machines at present available, or with others the construction of which will be indicated by the results of the inquiries.

IRRIGATION PUBLICATIONS.

During the year ended June 30, 1904, there were issued 5 bulletins, 1 Farmers' Bulletin, 2 circulars, 1 Yearbook article, and an article for the annual report of the Office. There were submitted for publication but not actually printed 5 bulletins and 1 special pamphlet for use at the St. Louis Exposition. Several separates have been reprinted, and a second edition of a large bulletin has been issued. The new matter published contains 717 pages and the second edition 330 pages.

The bulletins actually issued during the year were as follows:

Egyptian Irrigation, by Clarence T. Johnston, Assistant Chief of Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 130, pp. 100, pls. 24, figs. 9.)

This is a study of the irrigation laws and practices in Egypt, made with special reference to suggestions for improvements in American irrigation.

Plans of Structures in Use on Irrigation Canals in the United States, prepared under the direction of Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 131, pp. 51, pls. 22.)

This is an album of plans for irrigation structures, designed by leading irrigation engineers of the West, made from drawings exhibited at Paris in 1900 and at Buffalo in 1901.

Report of Irrigation Investigations for 1902, under the direction of Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations, containing the following reports: Irrigation in the Mountain Water District of Salt Lake County, Utah, by E. R. Morgan; The Use of Water from the Wood Rivers, Idaho, by J. D. Stannard; Irrigation Investigations on Sand Creek, Albany County, Wyo., by B. P. Fleming; Irrigation in Washington, by O. L. Waller; Irrigation Investigations in Montana, by Samuel Fortier; Irrigation

Systems on Stony Creek, Cal., by W. T. Clarke and C. W. Landis; Irrigation in the Black Hills, S. Dak., by A. B. Crane; Rice Irrigation in Louisiana and Texas, by Frank Bond; Third Progress Report on Silt Measurements, by J. C. Nagle; Irrigation Experiments at the Missouri Experiment Station, by H. J. Waters; Irrigation in Wisconsin in 1902, by A. R. Whitson; Irrigation Investigations in New Jersey, 1902, by E. B. Voorhees; Use of Pumps for Irrigation in Hawaii, by Jared G. Smith. (Bulletin No. 133, pp. 265, pls. 12, figs. 16.)

This bulletin gives the results of the fourth season's investigations of the problems of irrigation, the results obtained in similar investigations in previous years being reported in Bulletins 86, 104, and 119 of this Office.

Storage of Water on Cache la Poudre and Big Thompson Rivers, by C. E. Tait, Assistant in Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 134, pp. 100, pls. 5, figs. 10.)

The reservoirs built for the storage of the winter and flood discharges of these two streams are described, and some of the results of the use of stored water are also given.

The Acquirement of Water Rights in the Arkansas Valley, Colorado, by J. S. Greene, ex-State engineer of Colorado. (Bulletin No. 140, pp. 83, pl. 1, fig. 1.)

This bulletin discusses the laws of the State governing the acquirement of rights in relation to the physical conditions of the valley; the organization of canal companies and the contracts and agreements under which they dispose of water, in relation to physical conditions, State laws, and the prosperity of farmers and canal builders; and the judicial and administrative customs and institutions of the State as they affect the agricultural industry of the valley and the State as a whole. This bulletin is intended primarily for the benefit of intending investors and settlers. It gives them a knowledge of the conditions which should be looked into before investments are made and points out the sources of the desired information. It is also a study of the laws and institutions of the State from the standpoint of their effect upon the prosperity of the State, by one who has had a large part in developing the system under consideration and is deeply interested in the future of the State.

Drainage of Farm Lands, by C. G. Elliott, Drainage Expert, Irrigation Investigations, Office of Experiment Stations. (Farmers' Bulletin No. 187, pp. 40, figs. 19.)

This bulletin gives practical directions for laying out drains, digging trenches, laying tiles, and caring for drains. It gives also directions to enable farmers to determine what kinds of drains to make, how large to make them, and the cost.

Supplemental Report on Drainage in the Fresno District, California, by C. G. Elliott, Agent and Expert, Irrigation Investigations, Office of Experiment Stations. (Circular No. 57, pp. 5.)

A report on drainage plans for the district around Fresno, Cal., was published last year. This circular gives additional data on the rise and fall of the ground-water level during the year, to be used as a basis for computing the capacity of drains to be supplied.

Irrigation in the Valley of Lost River, Idaho, by Albert Eugene Wright, Agent and Expert, Irrigation Investigations, Office of Experiment Stations. (Circular No. 58, pp. 24.)

Lost River, Idaho, sinks in the sands of its bed and rises again below. Mr. Wright made a series of measurements to determine the losses of water from the river and the effects of diversions above the sinks on the flow of the river below. This report contains the result of his observations and measurements.

Review of Irrigation Investigations for 1903, by Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. iv, 469–502, pls. 6. (Reprint from Annual Report of Office of Experiment Stations for 1903.)

This is a report of the work of this Office for the year ended June 30, 1903, telling what work was carried on and the localities where it was done.

Preparing Land for Irrigation, by R. P. Teele. Pp. 12, pls. 2, figs. 5. (Reprint from Yearbook, 1903.)

This is a brief article on methods of clearing and leveling land, laying out ditches, and applying water, based on Bulletin No. 145, referred to hereafter.

The following publications were prepared and submitted for publication but not actually printed before the end of the fiscal year. They have since been issued:

Irrigation in Northern Italy, Part I, by Elwood Mead, Chief of Irrigation Investigations. (Bulletin No. 144, pp. 100, pls. 17, figs. 14.)

Doctor Mead spent the summer of 1903 in Italy studying the systems of administration of streams, construction of irrigation works, methods of operating canals, and agricultural practices. This bulletin is a partial report of his observations. It describes the irrigation works of Lombardy and Piedmont, the system of agriculture followed, the laws under which works are built and managed, and the laws and customs under which they are maintained and the water distributed to farmers. Cooperation in ditch management has gone much further in Italy than in the United States. The benefits derived from this are among the most important things brought out by this bulletin. Public control of the use of streams is also more complete in Italy than in the United States, the Government maintaining a board which determines the feasibility of proposed ditch projects and the likelihood of interference with existing rights.

Preparing Land for Irrigation and Methods of Applying Water. (Bulletin No. 145, pp. 84, pls. 7, figs. 33.)

Each year tens of thousands of farmers begin irrigation. Most of them come from sections where irrigation is not practiced, and they are therefore entirely unfamilar with methods of irrigation farming. This bulletin is prepared especially for such farmers. It deals with methods of removing sagebrush, leveling land, applying water, and the preparation of the land for the different systems of putting on water. The conditions governing the choice of a method of irrigating are discussed, and comparative statements of cost are given. There are many things about irrigation farming which can be learned by experience only, but this bulletin will be of great help to beginners by giving them the results of the experience of others. It is fully illustrated from drawings and photographs of the implements and structures used and methods employed.

Current Wheels: Their Use in Lifting Water for Irrigation. (Bulletin No. 146, pp. 38, pls. 4, figs. 21.)

Current wheels are often the cheapest means of raising small volumes of water short distances where much larger volumes are flowing by. A wheel can lift only a small percentage of the water passing it, and the cost of construction increases so rapidly with increased size that the large wheels necessary for high lifts can not be profitably built, but there are many places along streams and the upper sections of canals where enough water for a small area can be lifted a few feet with almost no cash outlay and without injury to lower users except for the small quantity of water taken. Bulletin No. 146 gives illustrations of a number of wheels which are in use, with statements as to the material required, the cost of construction, and the area served. With the drawings and data given in this bulletin any farmer having ordinary tools should be able to construct a current wheel.

Report on Drainage Investigations in 1903, by C. G. Elliott, Drainage Expert, Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 147, pp. 62, pls. 5, figs. 12.)

It is estimated that east of the one hundredth meridian there are about 75,000,000 acres of land too wet for agricultural use which can be reclaimed by drainage. West of that line there are large areas which, while they are in an arid region, receive sufficient drainage water from higher lands or from ditches to render them unproductive. These lands can also be reclaimed by drainage. The work of this Office has been the making of plans for the drainage of wet lands in all parts of the United States and the giving of advice on drainage projects. Bulletin No. 147 describes the conditions found in a number of localities examined and gives the plans worked out for their reclamation. While the report deals with specific localities, it is valuable for other regions, since it will suggest the steps which should be taken there.

Report on Irrigation Investigations in Humid Sections of the United States in 1903, under the direction of Elwood Mead. (Bulletin No. 148, pp. 45, pls. 3.)

This report deals almost exclusively with the irrigation of market-garden crops. Most of these grow rapidly and have but a short season, and a few days of dry weather seriously check their growth. There are few seasons when such dry periods do not occur, and irrigation as an insurance against them has proved very profitable. This bulletin contains a number of reports describing the works used and the crops raised in different sections. Irrigation in Market Garden Districts in the Vicinity of Eastern Cities, by E. B. Voorhees, describes a number of plants in the vicinities of Boston and New York and gives the cost and something as to the profits realized. Irrigation Experiments in New Jersey in 1903, by E. B. Voorhees, gives the results of experiments with asparagus and small fruits at the New Jersey Experiment Station. Irrigation During the Season of 1903 at Missouri Agricultural Experiment Station, by H. J. Waters, gives the results of irrigation of strawberries, asparagus, nursery stock, onions, and corn. One of the most notable results was the prevention of rust on asparagus. Irrigation in the Artesian Basin of South Dakota, by A. B. Crane, describes the wells in James River Valley of South Dakota and discusses the results of the use of their water for irrigation.

Irrigation and Drainage Investigations of the Office of Experiment Stations, by R. P. Teele. (Document No. 723, pp. 23, pls. 2, figs. 5.)

This is a general statement of the lines of work being carried on by this Office, primarily for distribution at the Louisiana Purchase Exposition. It gives the objects of the various lines of work undertaken and a brief statement of the methods employed and the results obtained.

In accordance with a joint resolution of Congress, a second edition of 4,000 copies of Bulletin No. 124, on Irrigation in Utah, was issued. This is a detailed study of the laws of Utah and the institutions of that State for controlling streams, managing ditches, and using water. It contains also a general discussion of irrigation in Utah, based on the more detailed reports given.

REPORT ON NEW DEPARTMENT BUILDINGS.

U. S. Department of Agriculture,
Office of Chairman of Building Committee,
Washington, D. C., November 26, 1904.

Sir: I have the honor to submit herewith a brief statement covering the work for the year on the new buildings for the Department of Agriculture, authorized by the act of Congress approved February 9, 1903.

Respectfully,

B. T. Galloway,
Chairman, Building Committee.

Hon. James Wilson, *Secretary.*

ORGANIZATION.

In accordance with your various orders issued from time to time, the organization empowered to handle all matters pertaining to the new buildings consists of a building committee, the members of which are Dr. D. E. Salmon, Chief of the Bureau of Animal Industry; Dr. A. C. True, Director of the Office of Experiment Stations, and the writer. By virtue of your further orders, the writer has been charged to act as chairman of the committee, and in such capacity makes all necessary recommendations, prepares requests for authorizations, requisitions, etc., approves accounts, and attends to such other necessary details as are connected with the work.

The Department has secured the services of Capt. John S. Sewell, Engineer Corps, U. S. Army, as its adviser on all matters pertaining to the construction of the buildings. By invitation of the Building Committee, Captain Sewell acts with this body at all of its meetings and joins in such recommendations as it is necessary to make in connection with the work.

In order properly to carry out all work connected with the mechanical equipment of the buildings, it has been necessary to secure the services of an experienced mechanical engineer. Early in the year a request was made on the Treasury Department for the transfer of Mr. R. Barnard Talcott for this work. It developed, however, that Mr. Talcott's services could not be spared from his present position, and, in accordance with the recommendation of the committee, he was appointed consulting mechanical engineer, and the services of Mr. S. F. Gardner, of the Supervising Architect's Office of the Treasury,

were secured. Mr. Gardner was appointed January 14, 1904, as mechanical engineer and superintendent to assist Mr. Talcott. Later Mr. H. L. Gilbert was appointed as draftsman to aid in the detail work connected with the preparation of plans for the full mechanical equipment.

GENERAL WORK.

The Building Committee has been occupied during the year in general work connected with the preparation of plans, specifications, etc., relating to the new buildings. Considerable attention was also given to matters pertaining to the location of the structures, various details bearing on the removal of the buildings now on the Department grounds, tests to determine questions relating to proper foundations, etc. In clearing the site to be occupied by the new buildings, four frame buildings have been removed, several greenhouses have been torn down, and the entire ground is now cleared with the exception of the Museum, which has been condemned and will be sold within a short time. It is hoped to have all the ground cleared not later than January 15, 1905.

Congress, in its action of February 9, 1903, authorized the expenditure of $250,000, and of this amount $40,266.76 has been expended in the general preliminary work, architects' fees, various expenses connected with testing foundations, incidentals for clerk hire, etc.

WORK OF THE ARCHITECTS.

Carrying out instructions from the building committee, the architects during the latter part of August, 1903, began their work on the plans. It was first necessary to make a thorough study of the requirements of the various Bureaus of the Department, and the grounds available for the buildings. The chairman of the Building Committee for the Department placed in the hands of the architects full and detailed statements in reference to the various requirements of the Department, and with these data and facts gathered as the result of personal studies the architects were able to submit, in November, 1903, preliminary plans for the new structures.

With a view to utilizing the grounds available for the Department to the best advantage, preliminary studies were made with the object of placing the buildings north of those now existing and facing toward the south. Carrying out the instructions of the Building Committee, the architects made a special effort to provide for the laboratory work good light in every room. With this as a basis, and in accordance with the views of the Building Committee, the architects arranged a group of buildings with a central administrative structure. The block plan submitted showed six of these buildings grouped symmetrically about the central one. This block plan and other preliminary drawings, after proper consideration by the committee, were approved and the architects were advised to proceed with the working drawings of three new laboratory buildings, this number being all that could be constructed with the available appropriation.

PROBLEMS CONNECTED WITH THE SITE OF THE VARIOUS BUILDINGS.

As the work of the architects progressed, it became evident that the location on the north side of the grounds was not entirely desirable. The matter of locating, therefore, on the south side was then taken up and considered in connection with the general plans for the improvement of the Mall advocated by the Park Commission. After considering the various propositions it was decided to locate the buildings on the south side of the Mall tract, and when this decision was finally reached it was found necessary to alter somewhat the general plans of the buildings. Carrying out the instructions, therefore, of the Building Committee, a revised block plan for the new location was prepared and submitted by the architects on March 11, 1904, the unit buildings of the group being substantially the same as arranged for the north side.

The plans as prepared locate the buildings on a line 445 feet from the axis of the proposed parkway, conforming to the report of the Park Commission. The site south of this line is only 188 feet wide, and it therefore eliminates the possibility of the erection of any future buildings, unless action is taken toward closing B street SW. The new plans provide for two L-shaped laboratory structures, each approximately 256 feet long by 60 feet wide, and each having a rear wing 100 feet long by 60 feet wide, extending to B street SW., and symmetrically arranged, one on each side of the proposed administration building centered on Thirteenth street. It is planned to have the administration building connected with the laboratories by curtain wings, making a frontage when completed of about 750 feet facing the Mall.

The work under this arrangement was actively pushed, and on July 30, 1904, complete working drawings and specifications were received from the architects for approval and checking by the Department's representatives. On August 19, 1904, a committee meeting was held for the final discussion of the details connected with the buildings. At this conference the drawings were ordered duplicated, the specifications were ordered printed, and on September 19, 1904, advertisements for proposals were made. Sixty applications for the drawings and specifications were received, which were sent out to the contemplated bidders under careful regulations formulated by the committee.

PROPOSALS FOR THE NEW STRUCTURES.

On November 10, 1904, twenty proposals for the general construction of two laboratory buildings which had been received were opened. It was found that a number of these proposals came within the limit of cost fixed by the architects and the Building Committee. In sending out the proposals the committee requested bids of two general kinds: First, structures complete with granite base and marble superstructure; and, second, structures complete, all granite. The sum of $300,000 was set aside for the general expenses connected with the work, including architects' fees, mechanical equipment, light, heat, power, etc., thus leaving $1,200,000 for the structures complete. The proposals received for the complete structures ranged from $1,153,000 to $1,612,000.

All the bids received careful consideration by the Building Committee and the architects, and the one that seemed most desirable, namely, that of Ambrose B. Stannard, of New York, was recommended for acceptance. Mr. Stannard submitted two bids—the first, $1,206,000, for Milford granite base and Vermont marble superstructure; the second, $1,199,000, for Jonesboro base and marble superstructure.

Of the various alternate items asked for by the Building Committee it seemed advisable that two of the alternate proposals required by the proposal sheets should be accepted: First, that for the substitution of terra-cotta floor construction in lieu of the steel and concrete slab construction specified; and, second, that for the omission of all marble wainscoting in the corridors of the buildings. This reduced the total proposal of Mr. Stannard on Milford granite base and Vermont marble superstructure to $1,171,000.

Owing to the difficulty of obtaining definite information from the small samples of stone submitted, Mr. Stannard was asked to name some building constructed of the same material proposed for the Department that could be used as a type. The post-office and custom-house at Newport News, Va., recently constructed by Mr. Stannard, under the direction of the Supervising Architect's Office of the Treasury, was named, and the chairman of the Building Committee, in company with the architects and representatives from the marble company, visited Newport News and made a personal examination of the stone used in this structure. The combination of marble superstructure and granite base was found to be very satisfactory, and the quality of stone was thereupon formally approved by the committee and the architects.

Mr. Stannard has been furnished with a formal letter of acceptance, in which are set forth various conditions relating to the work and upon which a contract will be prepared and formally executed within the next few days.

WORK RELATING TO MECHANICAL EQUIPMENT.

The preliminary mechanical equipment work was completed and incorporated in the general construction drawings and specifications, and the plans and specifications for the heating, electric lighting, telephone, bell, and standard-clock system, and a system of supply piping for the various laboratory requirements and power plant are now being prepared and will be put under contract at the proper stage of the construction of the new buildings.

OFFICES FOR ENGINEERS, DRAFTSMEN, ETC.

As suitable quarters were not available for the mechanical equipment and other new building work, temporary structures were erected for this purpose west of the present main building of the Department at an expense of $1,377.85. These buildings are fitted with the necessary drafting rooms, storage rooms for the use of material that may be sent in for examination, and consultation rooms for the use of architects, contractors, and others who are now or may be in the future connected with the work.

OTHER WORK OF THE BUILDING COMMITTEE.

In addition to looking after all the details connected with the construction of the new buildings proper, the Building Committee has prepared the plans for the temporary quarters of officers connected with this work. The committee has also looked after all the details connected with the preparation and carrying out of plans in connection with the construction of the new greenhouses authorized by the last Congress.

The mechanical engineer has also in the course of his other work prepared and had executed under his direction a number of plans for the heating of several offices connected with the Department.

RECOMMENDATIONS.

The growth of the Department has been very rapid during the past eighteen months, and the buildings it is proposed to erect will not begin adequately to provide for the various branches which are now housed in undesirable and makeshift structures. It is therefore earnestly recommended that an effort be made at the next Congress to secure an appropriation of not less than $1,500,000 for the proposed administration building, tentative plans for which have already been prepared. The greater portion of the work of the Department is conducted in laboratories; hence, immediate attention was given to such needs. It is highly important, however, that the administrative work of the Department receive better quarters and that early action be taken, especially for the preservation of the valuable Library at present housed in the old structure. An administration building constructed in accordance with the tentative plans already received would do much toward putting the Department in a position where the very best work could be performed.

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